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ABSTRACT

This final report describes a 3-year federally funded project designed to conduct an analysis of the factors that contribute to the performance of high intensity problem behaviors by students with severe disabilities. The project utilized a series of five integrated studies, which involved students with severe intellectual disabilities and the teachers who serve them, to define the theoretical and methodological issues related to the performance of high intensity behavior, develop a comprehensive assessment model for assessing and treating behavior response classes, and provide empirical documentation of the efficacy of the model. The objectives, activities, products, and accomplishments of the project are described and charts detailing the project's evaluation plan and timetables are included. The report includes a research report on three experimental analyses conducted to assess the effects of different consequent stimuli on the rate of self-injurious behavior (SIB) and stereotypical behavior of two individuals with severe developmental disabilities and dual sensory impairments. Findings indicate that noncontingent presentation of the specially selected stimuli resulted in reduction in stereotypical and self-injurious behavior. A concept paper that outlines an emerging model for assessing and treating low frequency, high intensity problem behaviors and data charts are also attached. (The concept paper contains 96 references.) (CR)

Final Report

# Multivariate Analysis of Severe Problem Behavior: Determining the Role of High Intensity Behaviors Within Functional Response Classes

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University of Oregon
Specialized Training Program

Initial Career Awards
H023N10010-93
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## Abstract

Multivariate Analysis of Severe Problem Behavior: Determining the Role of High Intensity Behaviors Within Functional Response Classes was a three year project to conduct an analysis of the factors that contribute to the performance of high intensity problem behaviors by students with severe disabilities. The project extended work by Jeffrey Sprague and his colleagues (e.g. Horner, Sprague, O'Brien, & Heathfield, 1990, Sprague & Horner, 1992) and initiated a comprehensive program of research to provide data on the effects of specific environmental and social variables that are hypothesized to contribute to the performance of high intensity problem behavior.

Despite twenty years of the implementation of the Least Restrictive Environment provision of P.L. 94-142, the trend to institutionalize or maintain institutionalization of persons with severe disabilities continues. The largest proportion of these individuals are institutionalized due to severe, high intensity problem behaviors. In addition, improved patterns of behavior are not necessarily associated with the transition to community settings.

Though there have been promising advances in functional analysis methods and single variable intervention techniques (e.g. manipulating a single consequence or antecedent variable), researchers and practitioners have been less successful dealing with the unique problems associated with managing high intensity behaviors. To date, the majority of studies (1) have been conducted in highly controlled settings, (2) provide limited documentation of generalization and/or maintenance of the effects, and (3) fail to systematically assess desirable and undesirable side effects of the intervention.

There is a pressing need to further develop and refine behavioral assessment and intervention techniques that can be applied to individuals whose behavior is regarded as most problematic in integrated community settings. While seminal work has been completed in the area, no efforts exist to systematically combine, test, and empirically validate a unified system of measurement and intervention.

The present project addressed this need by (1) defining the theoretical and methodological issues related to the performance of high intensity behavior, (2) developing a comprehensive assessment model for assessing and treating behavioral response classes, and (3) by providing empirical documentation of the efficacy of the model.

The project utilized a series of five integrated studies involving students with severe intellectual disabilities and the teachers that serve them. The studies employed a computer assisted direct observation system (Repp, Harman, Felce, Van Acker, & Karsh, 1989; Shamee & Sprague, 1992), and clinical tracking of specific setting events that are hypothesized to affect the behaviors of concern. Data were analyzed via single subject methodology, calculation of lag sequential dependencies, analysis of response effort and intensity, and social validity of data summaries.

The project had at least four direct outcomes relating to the delivery of behavioral technology for families, teachers, and community support staff. Specifically, the project (1) increased the knowledge base relating to ecological and social factors that contribute to the performance of high intensity problem behavior; (2) socially validated promising new measurement techniques; (3) demonstrated the integration of a variety of important and previously independent theoretical foundations; and (4) expanded the base for training activities and modules currently being developed at Indiana University and the University of Oregon. This project represents an important extension of the available data base on positive approaches to providing behavioral support for persons with severe intellectual disabilities.

## Project Objectives

The objectives of this project are focused on defining theoretical issues and describing intervention procedures that will result in effective treatment of high intensity problem behavior in integrated community settings. This section outlines specific project objectives and describes procedures for meeting each project objective. Table 1 provides an overview of project objectives and products. A complete description of the major grant activities are provided on pages 14-56 of the original application.

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Insert Table 1 about here

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**Objective 1: Develop a Concept Paper that Defines the Theoretical and Clinical Basis for Treating High Intensity Problem Behavior**. This objective relates to the development and publication of a major theoretical review and analysis of the literature on the treatment of high intensity problem behavior. Three activities have supported the development of the concept paper:

**Activity 1.1**: Conduct a comprehensive review of the experimental and applied literature on the phenomenon of high intensity behaviors and relevant related conceptual analysis.

**Activity 1.2**: Write a draft paper describing the theoretical model.

**Activity 1.3**: Submit paper for publication in appropriate book chapter (e.g. The final draft of the paper is included as Attachment A).

**Objective 2: Develop and field test a comprehensive data collection system for analyzing lag sequential and ecobehavioral relationships across a variety of classroom and community settings.** Objective 2 relates to activities for developing and validating a data collection system to be used for functional analysis assessment and ongoing intervention evaluation. Three studies are completed or in progress to accomplish a thorough field test and social validation of the measurement system. Detailed data collection methods and analysis procedures are presented on pages 16-31 of the original application.

**Activity 2.1**: Conduct a comprehensive review of the literature on behavioral measurement and assessment techniques.

## Table 1:

## Project Objectives and Products

| Objectives | Product |
|---|---|
| 1. Develop a concept paper that defines the theoretical and clinical basis for treating high intensity problem behavior. | A paper defining the theoretical and clinical model has been developed. |
| 2. Develop a comprehensive data collection system for analyzing sequential/ecobehavioral relationships across a variety of classroom and community settings. | A field tested clinical data collection system is under development and disseminated to researchers and practitioners. |
| 3. Conduct a descriptive observational study in diverse educational settings for students with severe disabilities who perform high intensity problem behaviors. | A descriptive study involving 10 participants was conducted. Publication in an appropriate professional journal is planned. |
| 4. Conduct an experimental analysis of the relationship between positive treatment strategies and high intensity problem behavior. | A clinical study involving two participants was conducted. Submitted for publication in an appropriate professional journal. |
| 5. Disseminate products of the project. | Local, regional, and national conference presentations were conducted. Studies will be published in appropriate professional journals. Information from the studies will be incorporated into training manuals and inservice activities. |
| 6. Manage and evaluate the project. | A final report has been submitted describing project activities and outcomes. |

**Activity 2.2**: Develop the measurement system. The measurement system consists of two types of information: (1) a direct observation behavioral coding system and (2) a clinical data system for monitoring the occurrence of identified setting events and ecological variables. Table 2 provides a listing of the data collection instruments and their current status. Sample data forms and data summaries were provided in the Year 2 continuation request.

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Insert Table 2 about here

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**Activity 2.3**: Obtain feedback on the measurement system from nationally recognized experts in behavior management technology.

**Activity 2.4**: Field test and evaluate the measurement system. A major field test of the measurement system was conducted in the first year of the project (FY 1991).

**Objective 3: Conduct a descriptive observational study in diverse educational settings for students with severe disabilities who perform high intensity problem behaviors.** A description of the research questions, participants, settings, measurement, reliability, and anticipated results is presented on pages 31-36 of the original application. This study has been completed and is being prepared for publication.

**Objective 4: Conduct an experimental analysis of the relationship between targeted intervention strategies and high intensity problem behavior.** The final study in the ongoing program of research involved a detailed experimental analysis of the variables affecting high intensity problem behavior. This study was carried out in year three of the project (FY 1993). Study methodology is presented in detail on pages 36-41 of the original application and in the journal article included as Attachment B.

**Objective 5: Disseminate products of the project.** The project dissemination plan includes preparation and publication of research reports, presentations at state, regional, and national conferences, and preparation and publication of a paper describing the theoretical and clinical model. Table 3 summarizes the completed, in progress, and planned dissemination activities of the project.

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Insert Table 3 about here

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Table 2:

Status of Data Collection Instruments

| Item | Status |
|---|---|
| Functional Analysis Interview (O'Neill, et al., 1990) | Available; consumer evaluation completed |
| Student demographic questionnaire | Completed |
| Setting Events Checklist | Completed; utilized in data collection activities |
| Direct Observation Code | Completed; individualized codes developed for each participant |
| Consumer Evaluation Form | Available; field test and participant evaluation completed |

Table 3:
Dissemination Activities

| Product/Event | Audience | Schedule of Dissemination |
|---|---|---|
| **Research Reports** | | |
| Concept Paper | Low Frequency High Intensity Problem Behavior: Toward an Applied Technology of Functional Assessment and Intervention. | Accepted |
| Descriptive Study | Research in Developmental Disabilities | In Preparation |
| Experimental Analysis | | Submitted for Publication |
| **Newsletter Articles** | | |
| LRE Reporter | Teachers, Administrators | Bi-annually |
| **Presentations (Regional and National)** | | |
| TASH | National: Parents, Teachers, Researchers | November 1993, 1994 |
| ABA | National: Researchers, Clinicians | May,1995 |
| AAMR | Regional: Teachers Administrators | November 1993, 1994 |
| **Presentations (State)** | | |
| ARC of Indiana | Parents, Special Educators | April, 1993 |
| Indiana LRE Conference | Parents, Teachers, Administrators | April 1992-1994 |

**Objective 6: Manage and Evaluate the Project.** This objective relates to the timely and effective completion of major project activities. Table 4 presents the evaluation concerns, evaluation questions, data sources, measures, and schedule of data collection. A detailed description of project management and evaluation activities is provided in the original application on pages 44-56.

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Insert Table 4 about here

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Timeline for the Major Tasks

The activities and timelines of the project are defined by each major objective. The timelines serve as the formal plan by which all project activities are evaluated in reports to OSEP. Table 5 presents a detailed timeline for each of the major tasks of the project.

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Insert Table 5 about here

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Table 4:
Project Evaluation Plan

| Evaluation Concern | Evaluation Question | Data Source | Measure | Schedule | Purpose |
|---|---|---|---|---|---|
| I. Development of Theoretical Paper for Addressing High Intensity Behavior | Is a model defined that is consistent with existing research yet useful for program development? | Editorial Reviews of Position Paper<br><br>Evaluation Questionnaire by Teachers and Service Providers | Qualitative Analysis<br><br>Social Validity: Effort and Utility | Upon admission<br><br>After paper written | Final report adjust content/format<br><br>Modify content as necessary |
| II. Research | Does research meet professional standards for scientific rigor? | Editorial Reviews of Research Report | Qualitative Analysis | Upon admission | Final report adjust content/format |
| III. Social Validity | Does the project document practical strategies for measuring High Intensity Behavior? | Evaluation Questionnaire by Teachers and Service Providers | Effort and Utility | Ongoing | Modify content as necessary |
| IV. Dissemination Results | Are results disseminated to research community? | Publication of two Research Reports | Information Dissemination Log | At the conclusion of the project with quarterly checks | Estimate overall project impact |
| | Are results disseminated to families and practitioners? | Research Reports Presentations Newsletter articles | Information Dissemination Log | At the conclusion of the project with quarterly checks | Estimate overall project impact |
| • Teacher and Classroom | What are the characteristics of teachers and providers who use the data system? | Demographic Questionnaire | Count by Response Category | At outset of participation | Descriptive report Evaluate threats to internal validity |
| • Participant Characteristics | What are the characteristics of students who participate in project studies | Demographic Questionnaire | County by Response Category | At outset of participation | Descriptive report Evaluate threats to internal validity |
| V. Management Plan | Are project objectives met in accordance with planned timelines? | Weekly staff meetings; quarterly planning documents | Discrepancy between planned/actual occurrence | Monitoring at weekly staff meetings; quarterly planning meetings with individual project staff and consultants | Adjust resource allocation or modify timelines as necessary to support task completion |

Table 5:
Project Activities and Timeline 1991-1994

| Project Tasks/Activities | 10/91 | 11/91 | 12/91 | 1/92 | 2/92 | 3/92 | 4/92 | 5/92 | 6/92 | 7/92 | 8/92 | 9/92 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.0 Develop a Concept Paper | | | | | | | | | | | | |
| 1.1 Conduct literature review | x | x | x | | | | | | | | | |
| 1.2 Write draft paper | | x | x | x | x | | | | | | | |
| 1.3 Submit for publication | | | | | | x | | | | | | |
| 2.0 Develop and Field Test Data Collection System | | | | | | | | | | | | |
| 2.1 Review literature and techniques | x | x | | | | | | | | | | |
| 2.2 Develop measurement system | x | x | | | | | | | | | | |
| 2.3 Obtain feedback | | x | x | | | | | | | | | |
| 2.4 Field test and evaluate | | | | x | x | x | x | x | x | | | |
| 2.5 Revise and prepare for dissemination | | | | | | | | x | x | x | x | x |
| 3.0 Conduct Descriptive Study | | | | | | | | | | | | |
| 3.1 Develop specific methodology for each subject | | | | | | | | | | | | |
| 3.2 Submit methodology for internal review | | | | | | | | | | | | |
| 3.3 Finalize methodology | | | | | | | | | | | | |
| 3.4 Begin study data collection | | | | | | | | | | | | |
| 3.5 Collect data | | | | | | | | | | | | |
| 3.6 Conduct reliability probes | | | | | | | | | | | | |
| 3.7 Monitor ongoing data collection | | | | | | | | | | | | |
| 3.8 Analyze data (efficiency, conditional probability) | | | | | | | | | | | | |
| 4.0 Conduct Experimental Analysis | | | | | | | | | | | | |
| 4.1 Develop specific methodology for each subject | | | | | | | | | | | | |
| 4.2 Submit methodology for internal review | | | | | | | | | | | | |
| 4.3 Finalize methodology | | | | | | | | | | | | |
| 4.4 Begin study with baseline data collection | | | | | | | | | | | | |
| 4.5 Train participants/collect data | | | | | | | | | | | | |
| 4.6 Conduct reliability probes | | | | | | | | | | | | |
| 4.7 Monitor ongoing training | | | | | | | | | | | | |
| 4.8 Analyze data | | | | | | | | | | | | |
| 4.9 Collect follow up data | | | | | | | | | | | | |
| 5.0 Dissemination | | | | | | | | | | | | |
| 5.1 Draft research reports | | | | | | | | | | | x | x |
| 5.2 Draft dissemination documents | | | | | | | | | | | | |
| 5.3 Preparation of research reports | | | | | | | | | | | | |
| 5.4 Submit proposal - National Conference | | | | x | | | | | | | | |
| 5.5 Submit proposal - State Conference | | | x | | | | | | | | | |
| 5.6 Submit results to journals | | | | | | | | | | | | |
| 5.7 Present results at National Conference | | | | | | | | x | | | | |
| 5.8 Present results at State Conference | | | | | | | x | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.0 | Manage and Evaluate | | | | | | | | | | | |
| 6.1 | Confirm agency agreements | x | | | | | | | | | | |
| 6.2 | Obtain Human Subjects Approval (10/91) | | x | | | | | | | | | |
| 6.3 | Finalize selection of participants | | x | | | | | | | | | |
| 6.4 | Acquire informed consent | | x | | | | | | | | | |
| 6.5 | Locate and hire data collectors | | | | | | | | | | | |
| 6.6 | Prepare training materials | x | | | | | | | | | | |
| 6.7 | Train data collectors | | | x | | | | | | | | |
| 6.8 | Train research assistant | x | | | | | | | | | | |
| 6.9 | Set training times with agencies | | | x | | | | | | | | |
| 6.10 | Conduct weekly project meetings | x | x | x | x | x | x | x | x | x | x | x | x |
| 6.11 | Meet with cooperating agencies | | | | x | | | x | | | x | | |
| 6.12 | Prepare quarterly project reports | | | | x | | | x | | | x | | |
| 6.13 | Conduct evaluation activities | x | x | x | x | x | x | x | x | x | x | x | x |

| Project Tasks/Activities | | 10/92 | 11/92 | 12/92 | 1/93 | 2/93 | 3/93 | 4/93 | 5/93 | 6/93 | 7/93 | 8/93 | 9/93 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.0 | Develop a Concept Paper | | | | | | | | | | | | |
| 1.1 | Conduct literature review | | | | | | | | | | | | |
| 1.2 | Write draft paper | | | | | | | | | | | | |
| 1.3 | Submit for publication | | | | | | | | | | | | |
| 2.0 | Develop and Field Test Data Collection System | | | | | | | | | | | | |
| 2.1 | Review literature and techniques | | | | | | | | | | | | |
| 2.2 | Develop measurement system | | | | | | | | | | | | |
| 2.3 | Obtain feedback | | | | | | | | | | | | |
| 2.4 | Field test and evaluate | | | | | | | | | | | | |
| 2.5 | Revise and prepare for dissemination | | | | | | | | | | | | |
| 3.0 | Conduct Descriptive Study | | | | | | | | | | | | |
| 3.1 | Develop specific methodology for each subject | x | | | | | | | | | | | |
| 3.2 | Submit methodology for internal review | x | | | | | | | | | | | |
| 3.3 | Finalize methodology | | x | | | | | | | | | | |
| 3.4 | Begin study data collection | | | x | x | x | x | x | x | x | | | |
| 3.5 | Collect data | | | x | x | x | x | x | x | x | | | |
| 3.6 | Conduct reliability probes | | | x | x | x | x | x | x | x | | | |
| 3.7 | Monitor ongoing data collection | | | x | x | x | x | x | x | x | | | |
| 3.8 | Analyze data (efficiency, conditional probability) | | | | | | | x | x | x | x | x | x |
| 4.0 | Conduct Experimental Analysis | | | | | | | | | | | | |
| 4.1 | Develop specific methodology for each subject | | | | | | | | | | | | |
| 4.2 | Submit methodology for internal review | | | | | | | | | | | | |
| 4.3 | Finalize methodology | | | | | | | | | | | | |
| 4.4 | Begin study with baseline data collection | | | | | | | | | | | | |
| 4.5 | Train participants/collect data | | | | | | | | | | | | |
| 4.6 | Conduct reliability probes | | | | | | | | | | | | |
| 4.7 | Monitor ongoing training | | | | | | | | | | | | |
| 4.8 | Analyze data | | | | | | | | | | | | |
| 4.9 | Collect follow up data | | | | | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.0 | Dissemination | | | | | | | | | | | |
| 5.1 | Draft research reports | | | | | | | x | x | x | | |
| 5.2 | Draft dissemination documents | | | | | | | x | x | x | | |
| 5.3 | Preparation of research reports | | | | | | | | | | x | x | x |
| 5.4 | Submit proposal - National Conference | | | | x | | | | | | | |
| 5.5 | Submit proposal - State Conference | | | x | | | | | | | | |
| 5.6 | Submit results to journals | | | | | | | | | | | x |
| 5.7 | Present results at National Conference | | | | | | | | | x | | |
| 5.8 | Present results at State Conference | | | | | | | | x | | | |
| 6.0 | Manage and Evaluate | | | | | | | | | | | |
| 6.1 | Confirm agency agreements | x | | | | | | | | | | |
| 6.2 | Obtain Human Subjects Approval (10/91) | | x | | | | | | | | | |
| 6.3 | Finalize selection of participants | | x | | | | | | | | | |
| 6.4 | Acquire informed consent | | | | | | | | | | | |
| 6.5 | Locate and hire data collectors | | | | | | | | | | | |
| 6.6 | Prepare training materials | | | | | | | | | | | |
| 6.7 | Train data collectors | | | | | | | | | | | |
| 6.8 | Train research assistant | | | | | | | | | | | |
| 6.9 | Set training times with agencies | | x | | | | | | | | | |
| 6.10 | Conduct weekly project meetings | | x | x | x | x | x | x | x | x | x | x | x |
| 6.11 | Meet with cooperating agencies | | x | x | x | x | x | x | x | x | x | x | x |
| 6.12 | Prepare quarterly project reports | x | | | x | | | x | | | x | | |
| 6.13 | Conduct evaluation activities | x | x | x | x | x | x | x | x | x | x | x | x |

| Project Tasks/Activities | 10/93 | 11/93 | 12/93 | 1/94 | 2/94 | 3/94 | 4/94 | 5/94 | 6/94 | 7/94 | 8/94 | 9/94 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.0 Develop a Concept Paper | | | | | | | | | | | | |
| 1.1 Conduct literature review | | | | | | | | | | | | |
| 1.2 Write draft paper | | | | | | | | | | | | |
| 1.3 Submit for publication | | | | | | | | | | | | |
| 2.0 Develop and Field Test Data Collection System | | | | | | | | | | | | |
| 2.1 Review literature and techniques | | | | | | | | | | | | |
| 2.2 Develop measurement system | | | | | | | | | | | | |
| 2.3 Obtain feedback | | | | | | | | | | | | |
| 2.4 Field test and evaluate | | | | | | | | | | | | |
| 2.5 Revise and prepare for dissemination | | | | | | | | | | | | |
| 3.0 Conduct Descriptive Study | | | | | | | | | | | | |
| 3.1 Develop specific methodology for each subject | | | | | | | | | | | | |
| 3.2 Submit methodology for internal review | | | | | | | | | | | | |
| 3.3 Finalize methodology | | | | | | | | | | | | |
| 3.4 Begin study data collection | | | | | | | | | | | | |
| 3.5 Collect data | | | | | | | | | | | | |
| 3.6 Conduct reliability probes | | | | | | | | | | | | |
| 3.7 Monitor ongoing data collection | | | | | | | | | | | | |
| 3.8 Analyze data (efficiency, conditional probability) | | | | | | | | | | | | |
| 4.0 Conduct Experimental Analysis | | | | | | | | | | | | |
| 4.1 Develop specific methodology for each subject | x | | | | | | | | | | | |
| 4.2 Submit methodology for internal review | x | x | | | | | | | | | | |
| 4.3 Finalize methodology | | x | | | | | | | | | | |
| 4.4 Begin study with baseline data collection | | | x | x | x | | | | | | | |
| 4.5 Train participants/collect data | | | x | x | x | x | x | x | x | | | |
| 4.6 Conduct reliability probes | | | x | x | x | x | x | x | x | | | |
| 4.7 Monitor ongoing training | | | x | x | x | x | x | x | x | | | |
| 4.8 Analyze data | | | | | | | | x | x | | | |
| 4.9 Collect follow up data | | | | | | | | | x | x | x | |
| | | | | | | | | | x | x | | |
| 5.0 Dissemination | | | | | | | | | | | | |
| 5.1 Draft research reports | | | | | | | x | x | x | | | |
| 5.2 Draft dissemination documents | | | | | | | x | x | x | | | |
| 5.3 Preparation of research reports | | | | | | | | | | x | x | x |
| 5.4 Submit proposal - National Conference | | | | x | | | | | | | | |
| 5.5 Submit proposal - State Conference | | | x | | | | | | | | | |
| 5.6 Submit results to journals | | | | | | | | | | | | x |
| 5.7 Present results at National Conference | | | | | | | | x | | | | |
| 5.8 Present results at State Conference | | | | | | | x | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.0 | Manage and Evaluate | | | | | | | | | | | | |
| 6.1 | Confirm agency agreements | x | | | | | | | | | | | |
| 6.2 | Obtain Human Subjects Approval (10/91) | x | x | x | x | x | x | x | x | x | x | x | x |
| 6.3 | Finalize selection of participants | | x | | | | | | | | | | |
| 6.4 | Acquire informed consent | | | | | | | | | | | | |
| 6.5 | Locate and hire data collectors | | | | | | | | | | | | |
| 6.6 | Prepare training materials | | | | | | | | | | | | |
| 6.7 | Train data collectors | | | | | | | | | | | | |
| 6.8 | Train research assistant | | | | | | | | | | | | |
| 6.9 | Set training times with agencies | x | | | | | | | | | | | |
| 6.10 | Conduct weekly project meetings | | | | | | | | | | | | |
| 6.11 | Meet with cooperating agencies | | x | x | x | x | x | x | x | x | x | x | x |
| 6.12 | Prepare quarterly project reports | | x | x | x | x | x | x | x | x | x | x | x |
| 6.13 | Conduct evaluation activities | x | | | x | | | x | | | x | | |

## Accomplishments and Planned Activities

The activities of the project were completed according to the original timelines. The major accomplishments of the project are presented below:

1. Completion of the Concept Paper. The paper has been submitted for publication and accepted. A copy of the final draft is included as Attachment A.

2. Development and Field Testing of the Data Collection System. All activities related to this objective are complete. In addition, new computer software was developed specifically to support the unique lag sequential analysis procedures required by the project. The Sequential Data Analysis Program (Sprague & Shamee, 1992) allows rapid analysis of lag sequential conditional probabilities as well as the statistical and functional significance of individual and aggregated observation sessions. This computer software greatly increases the efficiency of lag analysis procedures and allows rapid summary of observation data for clinical and experimental decision making. Sample summaries from the SDA program are provided in Attachment B. Continued development of the SDA program will result in more user friendly displays of the results. SDA analysis will be utilized in the preparation of research reports and dissemination materials and activities.

   Data collection system components are completed and ready for use in future data collection and dissemination activities. At least three doctoral students at the University of Oregon are utilizing the SDA program as a primary or secondary analysis tool for their doctoral research. Jeffrey Sprague and Robert Horner will continue to refine the sequential analysis procedures and develop the next program of research using SDA.

3. Completion of the Descriptive Study. The descriptive study is outlined under objective 3.0. All data collection activities related to the study are completed as planned and the effort and conditional probability analysis will be completed by Summer of 1995. If appropriate, these data will also be summarized in a professional research report.

4. Completion of the Experimental Analysis. The experimental analysis described under Objective 4.0 has been completed and submitted for publication. A copy of the publication draft is included as Attachment C.

5. Dissemination. All dissemination activities were completed as planned and at least four national and four state level conference presentations occurred. Preparation of research reports and detailed descriptions of the data collection system are completed.

6. Project Management and Evaluation. All activities related to project evaluation and management are completed.

Table 6 presents a status report on each project activity describing project accomplishments to date, those completed by the end of the first project year, those planned for the second year of funding, and those anticipated for the third year.

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Insert Table 6 about here

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ucts referenced in Table 6 are included as attachments to this report.

Table 6:
Final Report
Multivariate Analysis of Severe Problem Behavior: Determining the Role of High Intensity Behaviors Within Functional Response Classes
Grant #H023N10010

| Project Activities | Planned Status | Accomplishments |
|---|---|---|
| 1.0 Develop a Concept Paper | | |
| 1.1 Conduct literature review | No formal activity planned for FY 94. | Research articles and book chapters are collected and incorporated into the concept paper. |
| 1.2 Write draft paper | No formal activity planned for FY 94. | Paper completed and accepted for publication. |
| 1.3 Submit for publication | No formal activity planned for FY 94. | Paper completed and accepted for publication. |

| Project Activities | Planned Status | Accomplishments |
|---|---|---|
| 2.0 Develop and Field Test Data Collection System | | |
| 2.1 Review literature and techniques | No formal activity planned for FY 94. | Literature review completed as scheduled. |
| 2.2 Develop measurement system | No formal activity planned for FY 94. | Initial Measurement system development completed as planned.<br>Sprague continues to obtain assistance from Bishara Shamee to improve existing computer data analysis and summary routines. Ongoing improvement of the measurement system is planned |
| 2.3 Obtain feedback | No formal activities planned for FY 1994. | Empirical and social validation of the setting events chart, the functional analysis chart, and the direct observation system completed with participating teachers and families. Social validation data are reported in FY 1993 continuation request. |
| 2.4 Field test and evaluate | No formal activity planned for FY 1994 | Field test completed as planned in all participating sites. Data collection and consumer evaluation occurred as a regular data collection activity. |

| Project Activities | Planned Status | Accomplishments |
|---|---|---|
| 2.5 Revise and prepare for dissemination | No formal revision activity planned for FY 1994. | All development and field test activities were completed on schedule. |
| 3.0 Conduct Descriptive Study | | |
| 3.1 Develop specific methodology for each participant | No formal activity planned for FY 94. | Descriptive study data have been collected. Further analysis is being conducted by Sprague. |
| 3.2 Submit methodology for internal review | No formal activity planned for FY 94. | Descriptive study data have been collected. Further analysis is being conducted by Sprague. |
| 3.3 Finalize methodology | No formal activity planned for FY 94. | Descriptive study data have been collected. Further analysis is being conducted by Sprague. |
| 3.4 Begin study data collection | No formal activity planned for FY 94. | A total of 8 individuals participated in observation and data collection for the descriptive study in FY 1992. |
| 3.5 Collect data | No formal activity planned for FY 94. | Data collection was completed by 6/93. |
| 3.6 Conduct reliability probes | No formal activity planned for FY 94. | Reliability probes were collected at regular intervals during data collection. Refer to the study description of pages 31-36 in the original application for specific observer agreement procedures. |

| Project Activities | Planned Status | Accomplishments |
|---|---|---|
| 3.7 Monitor ongoing data collection | No formal activity planned for FY 94. | All data collection activities were monitored by Sprague during weekly project meetings and on site.<br><br>The primary project consultant (Horner) assisted in monitoring the schedule and appropriateness of data collection activities via meetings, facsimile transmissions, and telephone calls. |
| 3.8 Analyze data (efficiency, conditional probability) | No formal activity planned for FY 94. | Objective Completed. Data analysis procedures are described in detail on pages 31-36 of the original application. |

| Project Activities | Planned Status | Accomplishments |
|---|---|---|
| 4.0 Conduct Experimental Analysis | | |
| 4.1 Develop specific methodology for each subject | Individual participant methodology to be completed by 10/93. | Activity completed as scheduled. |
| 4.2 Submit methodology for internal review | Internal review activities to be completed by 11/93. | Activity completed as scheduled. |
| 4.3 Finalize methodology | Study methodology to be completed by 2/94. | Activity completed as scheduled. |
| 4.4 Begin study with baseline data collection | Study data collection to begin 12/93. | Activity completed as scheduled. |
| 4.5 Train participants/collect data | Participant training and data collection to begin 12/93. | Activity completed as scheduled. |
| 4.6 Conduct reliability probes | Reliability probes to begin 12/93. | Activity completed as scheduled. |
| 4.7 Monitor ongoing training | Ongoing study monitoring to begin 12/93. | Activity completed as scheduled. |
| 4.8 Analyze data | Data analysis to begin 6/94. | Activity completed as scheduled. |
| 4.9 Collect follow up data | Follow-up data collection to begin 6/94. | Activity completed as scheduled. |

| Project Activities | Planned Status | Accomplishments |
|---|---|---|
| 5.0 Dissemination | | |
| 5.1 Draft research reports | Research reports to be drafted 4-8/94. | Data collection and analysis procedures completed on schedule. |
| 5.2 Draft dissemination documents | Dissemination documents to be drafted 4-8/94. | Activity completed as scheduled. |
| 5.3 Preparation of research reports | Preparation of research reports for project year two to be completed 7-9/94. | Activity completed as scheduled. |
| 5.4 Submit proposal - National Conference | Proposal to be submitted to a national conference by 1/93. | Research presentation proposals were submitted to the Association for Persons with Severe Handicaps and the Association for Behavior Analysis per the required timeline. A presentation has been made at TASH and a final presentation has been accepted for ABA in May, 1995. |
| 5.5 Submit proposal - State Conference | Proposal to be submitted for State level conferences by 4/94. | A research presentation proposal has been made a the Indiana Federation of the Council for Exceptional Children per the required timeline. |
| 5.6 Submit results to journal | Research reports and dissemination documents to be submitted for publication by 9/94. | Research reports have been submitted or accepted for publication. |

| Project Activities | Planned Status | Accomplishments |
|---|---|---|
| 5.7 Present results at National Conference | Project results to be presented at a National Conference by 9/94. | Final project activities and products were presented at TASH in November 1994 and ABA in May 1995. |
| 5.8 Present results at State Conference | Project results to be presented at a State Conference by 4/94. | Project activities and research results were presented at the 1994 Indiana Federation Council for Exceptional Children, The 7th annual Indiana Conference on Least Restrictive Environment. |

| Project Activities | Planned Status | Accomplishments |
|---|---|---|
| 6.0 Manage and Evaluate | | |
| 6.1 Confirm agency agreements | Agency agreements to be confirmed by October 1993. | Activity completed as scheduled. |
| 6.2 Obtain Human Subjects Approval | Indiana University IRB approval to be renewed by November 1994. | Activity completed as scheduled. |
| 6.3 Finalize selection of participants | Selection of participants to be finalized by November 1993. | Activity completed as scheduled. |
| 6.4 Acquire informed consent | Informed consent to be obtained prior to the implementation of the Descriptive Study (Objective 3.0) | Activity completed as scheduled. |
| 6.5 Locate and hire data collectors | No formal activity planned. | Activity completed as scheduled. |
| 6.6 Prepare training materials | No formal activity planned for FY 1994. | Training materials for research assistant and data collector/observer are available. Training materials address use of laptop computers, observation protocols, scheduling, data summary, and data analysis. |
| 6.7 Train data collectors | No formal activity planned for FY 1994. | Activity completed as scheduled. |
| 6.8 Train support person | No formal activity planned for FY 1994. | Support person/ Research Assistant training was completed November 1991. |
| 6.9 Set training times with agency | Training times to be set with agencies by 11/93. | Activity completed as scheduled. |
| 6.10 Conduct weekly project meetings. | Project meetings to be conducted weekly. | Activity completed as scheduled. |

| Project Activities | Planned Status | Accomplishments |
|---|---|---|
| 6.11 Meet with cooperating agencies | Meetings with cooperating agencies are to be conducted regularly from 11/93 through the year. | Activity completed as scheduled. |
| 6.12 Prepare Project Reports | Continuation reports scheduled for November 1991, 1992, and 1993. | Continuation reports were submitted as per schedule. |
| 6.13 Conduct evaluation activities | Table 4 presents the project evaluation plan. The plan includes the evaluation questions for each project objective as well as the schedule of implementation. | Activity completed as scheduled. |

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# Attachment A:

# Concept Paper

Running Head: LOW FREQUENCY BEHAVIOR

# Low Frequency High Intensity Problem Behavior: Toward an Applied Technology of Functional Assessment and Intervention

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Sometimes the more measurable drives out the most important.

Rene' Dubos

# Low Frequency High Intensity Problem Behavior: Toward an Applied Technology of Functional Assessment and Intervention

Managing severe problem behavior remains among the most pressing challenges in special education and human services. Behavior that results in self-injury, injury to others, significant property damage, and impaired learning creates an obstacle to community living (Pagel & Whitling, 1978) and is a major reason for admission and readmission to state institutions (Bannerman, 1987; Tausig, 1985). A large proportion of the individuals (47% national average) still living in institutions perform severe, problem behaviors (Borthwick-Duffy, Eyman, & White, 1987; Scheerenberger, 1990; White, Lakin, Bruininks, & Li, 1991). In addition, while positive learning and social outcomes typically are associated with movement from institutional to community settings, patterns of reduced problem behavior are less evident (Larson & Lakin, 1989).

Significant emotional and financial costs, as well as safety factors, characterize the effects of severe problem behavior. High intensity behaviors that result in tissue damage, property damage, or extreme disruption are described as most problematic (Borthwick-Duffy et al., 1987). In addition, high intensity behaviors are associated with the most intrusive interventions including electrical stimulation, restraint, medication, and isolation (Guess, Helmstetter, Turnbull, & Knowlton, 1987; Lovaas & Favell, 1987). As such, the importance of decreasing high intensity behavior is used as justification for the use of the most aversive and intrusive treatments (e.g. Linschied, Iwata, Ricketts, Williams, & Griffin, 1990).

For some individuals, these behaviors occur unpredictably, and for reasons that are unclear (Carr, 1988; Patterson, 1982). This phenomenon can be especially frustrating for

families and direct care providers. The result is extreme stress, concern for personal safety and the safety of others, and ultimately institutionalization, more restrictive placement, or repeated failures to develop effective interventions (Bannerman, 1987; Tausig, 1985).

## Exemplary Treatment of Severe Problem Behavior

The debate over the use of severe aversive procedures to manage problem behaviors (Guess et al., 1987; NIH Consensus Development Panel, 1989) has emerged from an "aversive" versus "nonaversive" division (Repp & Singh, 1990; Mulick, 1990) toward productive evaluation of existing assessment and intervention techniques and discussion of critical areas needing further investigation.

The focus on the use of aversive procedures has stimulated a re-evaluation of methods for assessing and treating high intensity problem behavior. We are encouraged to use functional analysis assessment procedures, and to design interventions in response to information about the events that occasion and maintain the problem behavior. (Carr, Taylor, Carlson , & Robinson, 1990; Donnellan, LaVigna, Negri-Schoultz, & Fassbender, 1989; Durand & Crimmins, 1987; Iwata, Dorsey, Slifer, Baumann, & Richman, 1982; Mace, Webb, Sharkey, Mattson, & Rosen, 1988; Meyer & Evans, 1989; Van Houten , Axelrod et al., 1988; Wacker et al., 1990). New standards for intervention require that behavioral interventions will be based on the hypotheses generated by the functional analysis. Applied interventions require simultaneous manipulation of distal and immediate antecedent events, teaching appropriate behaviors that achieve the behavioral function of the problem behavior(s), and providing differential consequences for both desired and problem behaviors

(Bailey & Pyles, 1989; Carr, 1988; Carr, Robinson, & Palumbo, 1990; Durand, 1990; Horner et al., 1990; Sprague & Horner, 1992).

A range of studies utilizing both positive and aversive procedures document successful treatment of serious problem behaviors such as severe self-injury (e.g. head banging, eye poking), aggression (e.g. hitting or biting others), and property destruction (e.g., breaking furniture or windows). Classes of intervention include (a) training functionally equivalent communication behaviors (Durand, 1990; Durand & Carr, 1987; Horner & Budd, 1985), (b) removing or changing antecedent stimuli (e.g. Carr & Durand, 1985; Horner, Day, Sprague, O'Brien, & Heathfield, 1991), (c) providing competing positive and aversive consequences for desirable and problem behavior (e.g. Cataldo, Ward, Russo, Riordan, & Bennett, 1986) Linscheid et al., 1990), and (d) preventing serious problem behavior repertoires in young children (Dunlap, Johnson, & Robbins, 1990). The advances of the past ten years are impressive but there is little in the current literature that provides empirically valid demonstrations of multi-element interventions in applied settings (Carr & Carlson, 1993; Lucyshyn, Olson, & Horner, in press).

The need for an improved applied treatment technology for high intensity behaviors has been expressed in recent analyses of behavioral interventions (Carr, Taylor, & Robinson, 1990; Helmstetter & Durand, 1991) and in federal panel reports on destructive behavior (National Institutes of Health, 1991; Reichle, 1990). Areas needing further study include setting event and biological interactions, measurement of response intensity, the influence of challenging behavior on others, and intervention procedures for low frequency, high intensity behavior problems. Further, demonstrations of the utility of complex, multi-component

assessment and intervention procedures in applied community settings are needed. Each of the above areas encompass the unique problems presented by low frequency, high intensity behaviors.

## Unique Problems of Low Frequency, High Intensity Behaviors

Successful treatment of low frequency, high intensity behaviors will require the development of expanded alternatives to existing single subject research methodologies. Renewed interest in response class theory, setting event analysis, and advanced measurement techniques provide the framework for an expanded model of functional assessment and intervention for this unique class of problem behavior.

The primary limitation of the existing single subject research methodology involves the difficulty of directly manipulating conditions that effect low frequency, high intensity behaviors such as severe aggression, self-injury, or property destruction (e.g. setting fires). The very nature of these behaviors resists traditional behavior analysis research designs that require relatively high frequency behaviors. Both to assessing and treating behaviors that are not manipulated easily or safely in a controlled setting is difficult (Iwata, Pace, Kissel, Nau, & Farber, 1990; Lovaas & Favell, 1987). For example, implementing a reversal design that requires repeated presentation of conditions for self-injurious head banging is ethically unacceptable, and can even result in strengthening the behavior.

The antecedent events that occasion high intensity behaviors are extremely complex and are difficult to produce under controlled conditions (Engelmann & Colvin, 1983; Patterson, 1982). The inability to occasion a specific behavior (the dependent variable) at a relatively high rate (i.e., multiple times per experimental session) creates a situation where

traditional single subject methods are not sufficiently sensitive to treatment effects. As such, long time intervals may be required to assess treatment effects, thereby increasing the chance of serious injury or the establishment of new problems (Iwata, Vollmer, & Zarcone, 1991).

There is a pressing need to develop and refine further the assessment and intervention techniques to be used with individuals who perform low frequency, high intensity behavior. This paper outlines selected theoretical and clinical advances contributing to a comprehensive model of treatment for these behaviors. The role of response classes, setting events, and sequential analysis methods are described and integrated into a comprehensive model of assessment and intervention.

The following section outlines an emerging model for assessing and treating low frequency, high intensity problem behaviors, and provides applied examples of model components. Each component is described in the following sections.

## Foundation: Response Class Theory

There are three major theoretical foundations of the proposed model. These include research on functional response classes and response covariation, the role of setting events and establishing operations, and promising advances in objective measurement techniques. Each is described below with reference to the assessment and treatment of low frequency, high intensity behaviors.

### Response Classes and Covariation

A response class is a set of topographically different behaviors that produce the same functional effect (Millenson & Leslie, 1979; Johnston & Pennypacker, 1980). Members of a response class are predicted to covary as consequences associated with individual members of

that response class change. Thus, procedures that affect a single member of a response class should produce collateral effects on other members of the response class (Dunham & Grantmyre, 1982; Parrish, Cataldo, Kolko, Neef, & Egel, 1986). Discussions of the role of response classes appeared early in the behavior analysis literature (Hull, 1943; Skinner, 1938). Response classes have been defined in terms of common antecedent or consequent stimulus relations (function), and in terms of topographical similarity (Baer, 1982; Johnston & Pennypacker, 1980).

Low frequency, high intensity behaviors typically have been defined in terms of the danger, damage, and inconvenience they impose on others. As researchers and clinicians have become more aware of the communicative function or "intent" of problem behaviors (e.g., Donnellan, Mirenda, Mesaros, & Fassbender, 1984; Doss & Reichle, 1991), a shift has occurred toward the classification of behavior in terms of the function it serves for the person, rather than the impact the behavior has on the teacher (e.g. Carr, McConnachie, Levin, & Kemp, 1993). Though researchers and teachers continue to classify behavior as "destructive," "self-injurious," or "aggressive," there is increasing reference to the role these behaviors serve to "obtain attention," "avoid unpleasant situations," "escape disapproval," "maintain self-stimulation," and so forth.

The emphasis on behavioral functions supports research and the common observation that a person seldom performs a single problem behavior. Data suggest that these different "ways" are not independent behaviors, but rather are members of a functional response class all performed to achieve a common effect. Figure 1 provides an illustration of multiple behaviors that may be used together or in isolation in order to achieve a functional behavioral

outcome. Response class theory and research suggest that intervention should be focused on affecting the entire class, not only the individual behavior(s) that are judged as problems (Sprague & Horner, 1992). In this example, the low frequency, high intensity behavior (hit head, scream) is a member of a functional response class and should be subject to the same intervention logic as lower intensity members. This recommendation differs from intervention models which emphasize sequential treatment of the most dangerous behaviors first, followed by those that are more tolerable (e.g. Evans & Meyer, 1985). For example, a comprehensive punishment program might be developed for low frequency, high intensity head hitting, while moving toward the teacher (both members of the response class "obtain attention") would be considered a low priority and ignored.

Insert Figure 1 About Here

Response covariation refers to changes in the probability of one behavior being emitted as a function of changes in the probability of other behaviors. For example, it is possible to treat low frequency, high intensity behaviors indirectly by treating lower intensity members of the response class (Van Houten & Rolider, 1988). Response covariation is especially relevant for designing treatments to reduce serious problem behaviors (Parrish et al., 1986) and is based on three compatible lines of research. These include the matching law, behavioral allocation, and functional equivalence.

The matching law. Response covariation can occur as a function of the matching law (Davison & McCarthy, 1988; Herrnstein, 1970). The matching law predicts the relative probability of multiple responses based on the schedule and quality of reinforcement available

for each response . The matching law provides a mathematical model for predicting the covariation of multiple responses (Epling & Pierce, 1990; Mace, McCurdy, & Quigley, 1990; McDowell, 1988; Myerson & Hale, 1984) and predicts that each member of a functional response class will be performed at a rate roughly equal to the relative value of the consequences produced by that response.

The matching law provides direct recommendations for the assessment and treatment of low frequency, high intensity behaviors. Recent applications of the matching law in applied contexts have emphasized the need to assess both the comparative frequency and quality of reinforcement available for different responses and the requirements (e.g., efficiency) of the different responses (Horner & Day, 1991; Mace et al., 1990). It is likely that lower intensity behaviors would be performed more often as they provide low cost (effort) and relatively consistent (delay, schedule) reinforcement most of the time. Alternatively, low frequency high intensity behaviors would pay off more consistently (every time), immediately (no delay) but require higher effort to perform. For example, if a student asks for help in order to avoid performing a difficult task, the teacher may occasionally postpone reinforcement by requiring slightly more work. Alternatively, if the student hits the teacher and screams (low frequency and high intensity), the task is terminated immediately (and every time).

Behavioral Allocation. A second, and compatible, phenomenon is behavioral allocation. Regardless of the consequences of a behavior, there is a limit to the number of responses a person can emit during a specified time period. Increases in time spent performing one behavior result in decreases in time available to perform other behaviors (Cataldo et al., 1986; Fisher, Piazza, Cataldo, & Harrell, 1990; Parrish et al., 1986). Like the

matching law, behavioral allocation has emphasized the point that many different factors affect the covariation of responses, including the decrease in opportunity to perform one behavior given occurrence of a different behavior. Interventions utilizing a behavioral allocation logic include differential reinforcement of incompatible behavior (DRI) (Tarpley & Schroeder, 1978) and differential reinforcement of alternative behavior (DRA) and it's variant, differential reinforcement of communication (DRC) (Carr, 1988). For example, the more often a student moves toward the teacher or throws paper to gain teacher attention (low intensity but high frequency behaviors), less opportunity is available to engage in head hitting (low frequency, high intensity behavior). Reinforcing lower intensity response class members ensures greater allocation of responding toward these more tolerable behaviors and reduces opportunity to perform the higher intensity (and less tolerable) behaviors.

Functional Equivalence. A third area of research has investigated the functional equivalence of *new* response class members (Carr, 1988). Functional equivalence training is based on functional analyses that result in documentation of stimulus events that occasion and maintain problem behaviors (Bijou & Baer, 1968; Bijou, Peterson, & Ault, 1968). A new behavior is taught and added as a new response class member to the extent that it results in the same consequence as the problem behavior. The new, desirable behavior will compete successfully with problem members of the response class only if it results in equal or greater reinforcement (the matching law) and it displaces opportunities to perform other behaviors (behavioral allocation). Teaching a low intensity behavior that is easier to perform and results in consistent reinforcement would reduce the probability of occurrence of low frequency, high intensity response class members. Empirical support for the predicted

covariation associated with functional equivalence training is impressive (e.g., Durand & Crimmins, 1987; Horner & Budd, 1985; Horner, Sprague, O'Brien, & Heathfield, 1990; Sprague & Horner, 1992; Wacker et al., 1990) but no studies to date have specifically assessed the effect on low frequency, high intensity behaviors.

The foundation concepts of response class theory that encompass response covariation, the matching law, behavioral allocation, and functional equivalence demonstrates that the magnitude and quality of concurrently available reinforcers can provide a basis for predicting which of many available behaviors will be performed at a given point in time. The type, amount, and delay in obtaining a given consequence will determine which member of a response class will be performed (Horner & Day, 1991). Assessment of the relative value of competing reinforcement in applied settings documents a critical, yet poorly understood, phenomenon in the investigation of low frequency, high intensity problem behaviors.

## Foundation: Complex Stimulus Control

### Setting events

The second theoretical underpinning focuses on the assessment and manipulation of the effect of complex and proximal or distal environmental stimuli. These have been referred to as setting events or establishing operations (Leighland, 1984; Michael, 1982; Wahler, 1975). For some time, individuals involved in direct service and clinical research have attempted to analyze the influence of these stimuli on the occurrence of problem behaviors (Chandler, Fowler, & Lubeck, 1992; Vollmer & Iwata, 1991). Research has focused on the impact of setting events on the value of immediate antecedent and consequent stimuli.

Individuals who perform serious problem behaviors often do so in a somewhat inconsistent manner. That is, they may respond to a situation appropriately at one time, and respond by performing a problem behavior at another time. For example, during an evening a person may not eat or sleep well, may be given medication, or may have a problematic interaction with another person. These events may then have an impact on how the person responds later that evening or the next morning. If a person is tired, agitated, or feeling medication effects, she/he may respond with problem behavior in a situation in which appropriate behavior is typical (e.g., being asked to complete a certain task). Alternatively, the person may experience a seizure, or become fatigued during the morning, which may then contribute to the occurrence of problem behaviors later in the day.

Setting events have been shown to be highly correlated with certain types of problem behavior in applied contexts (Gardner, Cole, Davidson, & Karan, 1986; Horner, Vaughn, Day, & Ard, in press; Patterson, 1982; Wahler, Leske, & Rodgers, 1979). Experimental manipulations have documented the influence of specific establishing operations (Chandler et al., 1992; Vollmer & Iwata, 1991). To date, research has focused on describing the relationships between specific variables and stereotypical behaviors (Horner, 1980; Brusca, Nieminen, Carter, & Repp, 1989), self-injurious behaviors (Schroeder et al., 1982), and aggression (Gardner, Karan, & Cole, 1984; Gardner et al., 1986). While the findings are important, research has not demonstrated the full influence of these variables within the larger context of behavioral theory (Michael, 1993: Morris, 1993).

There is a great need to develop further an applied setting event assessment methodology. Strategies have focused on use of clinical data (Reid, 1978; Gardner et al.,

1986) in the form of simple event checklists. Researchers working with students who have conduct disorders (e.g. Strain & Ezzel, 1978) and aggressive families (Patterson, 1982) have discovered strong relationships between global environmental factors and the performance of problem behavior. With the exception of the work of Gardner and his colleagues (e.g. Gardner et al., 1986) little analysis has been completed in applied settings with persons with developmental disabilities who perform low frequency, high intensity behaviors. The potential impact of setting events theory on understanding and treating these behaviors is immense. The traditional S--R--S equation must be expanded to acknowledge the impact of setting events (complex stimulus control) and establishing operations on reinforcer value.

## Foundation: Assessment and Analysis Strategies

The final theoretical foundation involves advances in behavioral assessment and analysis technology. Strategies for documenting the complex stimulus-response relationships described above have become increasingly more sensitive and descriptive. Research also has stressed the importance of measuring response intensity (Iwata et al., 1990; Patterson, 1982), efficiency (Horner et al., 1990), conditional probability of individual behaviors (Carr, Robinson, Taylor, & Carlson, 1990), and the multiple stimulus-response relationships that exist in contexts involving low frequency, high intensity behaviors. Promising practices to date involve the use of the technology of functional assessment (Iwata et al., 1982; O'Neill, Horner, Albin, Storey, & Sprague, 1990) and sequential analysis of teacher-student interactions (Bakeman & Gottman, 1986; Patterson, 1982; Repp, Harman, Felce, VanAcker, & Karsh, 1989). Each of these strategies is described in detail below.

Functional Assessment.

Functional assessment refers to the determination of the behaviors of concern, the stimulus conditions that occasion those behaviors, the consequences that are maintaining the behaviors, and the formation and testing of hypotheses regarding the function(s) of those behaviors (Axelrod, 1987; Carr, 1988; Durand & Crimmins, 1988; Iwata et al.,1982; O'Neill et al., 1990).

Functional assessment may involve up to three activities. First, an interview is conducted with care givers to define the behaviors of concern, antecedents, consequences, and hypothesized functions of problem behavior (Durand & Crimmins, 1987; O'Neill et al., 1990). The information from the interview is then used to design in vivo observation samples (Touchette, McDonald, & Langer, 1985) or analogue manipulations (Iwata et al., 1982) that allow testing of the hypotheses. Data are then used to design interventions directly related to the function (get/obtain or escape/avoid) of the behaviors of concern. The methods and logic of functional assessment technology can be greatly enriched with the incorporation of modern sequential analysis techniques. These methods are explained below.

Sequential Analysis Methods

A technology of direct observation that allows the analysis of sequential relationships between an individual, the environment, and the persons who interact with him/her holds significant promise for increasing the efficiency and accuracy of functional assessment efforts. These techniques have been used to assess families with conduct disordered children (Patterson, 1982), mother-infant interactions (Bakeman & Gottman, 1986), counseling interactions (Wampold & Kim, 1989), mother-child interactions (Snyder & Patterson, 1988),

institutionalized persons with mental illness (Natta, Holmbeck, Kupst, Pines, & Schulman, 1990), and, more recently, with individuals with severe disabilities and problem behavior (Martens & Houk, 1989; Repp, Felce, & Barton, & Lyle, 1988; Repp et al., 1989). The strategy typically involves the use of computers and software specifically designed to allow the simultaneous tracking of multiple behavior and stimulus events in a real time context (Martens, Melier, & Springer, 1987; Repp et al., 1989). Unique outcomes include the ability to assess transitional probabilities, and interactive social and environmental influences within a real-time framework. These tools represent a great improvement in observational accuracy over more traditional frequency, duration, or interval based measures typically used in behavioral research. The result is a richer and more accurate analysis of behavioral functions and causes. Practitioners and researchers can ask more sophisticated questions regarding the role of specific antecedent and consequent stimuli and the effects of the problem behaviors on ecology of the interaction.

Measurement of Response Efficiency and Intensity

While it is less well-documented than other measurement processes, the measurement of response efficiency and intensity is an increasingly present variable for research on severe problem behaviors (Carr, 1988; Iwata et al., 1990; Patterson, 1982). Measures of efficiency are central to determining the functional equivalence of alternative behaviors (Carr, 1988; Horner & Billingsley, 1988, Horner & Day, 1991). The contribution of functional equivalence is to ensure that the alternative behavior selected to replace a problem behavior actually will replace it (Horner & Billingsley, 1988). This "competing behavior analysis" strategy is a potentially useful approach. For example, if a communication behavior is

established to provide the same function as the excess behavior and intended to replace it, why then does the problem behavior decrease? Why doesn't the individual use both members of the response class? There is growing evidence that the behavior that is more efficient in terms of physical effort and schedule of reinforcement will be performed more frequently.

Evidence of this phenomenon is provided by Horner et al. (1990) who taught a young man with mental retardation and severe problem behaviors two different communication strategies to request assistance under difficult task conditions. One strategy involved a "high effort" communication response (typing "help please" on a small calculator device) and another involved a "low effort" response (touching a single symbol). Independent ratings of videotape samples assessed the level of effort required for each response strategy. The problem behavior (aggression) was rated as being approximately equal to "high effort" and significantly higher than the "low effort" strategy on a scale of effort expended. After training, the "low effort" communication response replaced both aggression and the "high effort" response. Though quite promising, there is a need to further test and refine our understanding of this phenomenon.

## The Framework for Intervention: An Expanded Model of Behavior Analysis

The foundation concepts described above can be integrated in an expanded model for assessing and treating low frequency, high intensity behaviors. An illustration of the model is provided in figure 2 and incorporates findings from recent work utilizing the methodologies described above. Kanfer and Phillips (1970) provided a seminal version with the SORKC model (antecedent stimulus, organismic variables, responses, contingency, and consequence).

The model described here expands to include consideration of setting events and establishing operations and requires the consideration of a broader range of antecedent and consequent stimuli. The effect of individual stimuli, stimulus classes, and competing stimuli must be considered. The momentary effect of setting events on the value of available reinforcing stimuli will vary and effect the topography and function of the response an individual may perform at a given point in time. Finally, the particular response that is emitted will result in a consequence of varying value over time and as a function of the particular response emitted. The important contribution of this model is the recognition that behavior has multiple antecedent and consequent stimulus determinants and these change in value and salience over time and across contexts.

Insert Figure 2 About Here

Figure 3 provides an illustration of an applied example of the expanded model (Horner et al., in press). The student is presented with instructional materials and a teacher request to complete the task. Interpreting the situation would involve the following analyses:

Insert Figure 3 About Here

Component One: The effect of setting events and establishing operations.

The first class of variables to consider are the setting events and/or establishing operations that affect the current value of available reinforcers and the ability of the student to attend to relevant antecedent stimuli. These events include temporally and proximally distant events such as a fight with a peer, no breakfast, and a headache. Additional factors that are

concurrently available in the stimulus complex include a snack on the back table in the classroom and other students. These events may act independently or collectively to affect the value of different consequent stimuli and thus play a role in determining which available response is performed. In the current example, a peer fight, hunger, and a headache may change the probability that problem behaviors will be performed. The momentary effect of these setting events may increase, decrease, or have no effect on the probability of low frequency, high intensity behavior performance.

Component Two: The value of available consequent stimuli.

The second component considers the absolute and comparative value of all possible consequent stimuli for the student. Reinforcer value occurs on a continuum. Available events may have reinforcing, aversive, or neutral values for the student at any given moment. An important recommendation of the model is to assess the value of consequent stimuli and the effect on the stimulus control properties of selected antecedent stimuli. The degree of stimulus control is influenced by the current value of available consequent stimuli. The most valuable consequent stimuli will be associated with stronger stimulus control of the responses associated with that consequence. An applied illustration is provided in figure 3 (above).

For the student, available consequences include task avoidance, more work, teacher praise, access to food, and reduced headache pain. The teacher should anticipate different responses if the student is (a) particularly motivated to obtain teacher praise, or (b) hungry, or (c) in a state of agitation (from pain) that makes escape from instruction particularly valuable.

Component Three: antecedent stimuli.

The third level of analysis considers the available antecedent stimuli presented to the student at any given point in time. In the current example, the teacher presents the student with task materials and a request to perform the task. Some stimuli will neither increase nor decrease the probability of behavior(s). These may be stimuli such as the snack, other students in the room, or normal classroom sounds. There will be other stimuli, however, that are associated with reinforcing consequences from the student's learning history, and which function as discriminative stimuli for certain responses or response classes. In the current example, the student is presented with the combined antecedent stimulus of new task materials and a teacher request. These stimuli may occasion completing the task or behaviors that result in task avoidance. At the same time the presence of food in the classroom can occasion an appetitive response. The teacher needs to be aware that at any given moment, many stimuli (and responses) are available for the student. Many stimulus control relationships are present concurrently and the student will attend (and ultimately respond) to some or all of the available stimuli. Low frequency, high intensity behavior will occur if the appropriate (low frequency) stimulus conditions exist.

Component Four: consideration of available responses.

The fourth component requires consideration of the range of available response options in a given stimulus context. Competition can occur between responses that result in different consequences (e.g., escape from instruction versus teacher attention) and in different responses that are performed to produce a common functional effect ("throw materials" versus "ask for break"). The outcome of this competition is affected by the relative value of the

competing consequent stimuli, the salience of antecedent stimuli, and the efficiency of the competing behaviors (Horner & Billingsley, 1988). In our example, available responses include screaming, running, throwing materials, asking for a break, asking for help, head hitting, rocking, grabbing the snack, or performing the task. Which response is performed will be determined by the stimulus control relationships that are competing at any one moment.

Component Five: Identification of response consequences.

The final consideration in the model is the type and magnitude of the consequences that result from performing a particular response. Responses will be influenced by the particular type, amount, and schedule of reinforcement available. Our student may perform the task, engage in problem behavior to avoid the task, or perform another behavior to obtain a different functional effect. The student performs minor problem behaviors often in the context of instruction. Less often, she performs very dangerous behaviors. The teacher must recognize that the consequences resulting from problem behavior performance (i.e. escape) are more valuable in relation to those available for task completion and under certain low frequency conditions a high intensity behavior is performed to produce that effect.

The five components diagram a behavioral ecology that is in continuous transformation as setting events, antecedent stimuli, consequences and response options change. The model is an interactive representation of the relationships between multiple stimuli and behaviors and can provide new directions for research and clinical practice. The model is particularly relevant for the analysis and treatment of low frequency, high intensity

problem behaviors as it provides parameters to interpret the structure of complex response classes that include those high intensity members.

Future analyses of low frequency, high intensity behavior must capture the complexity and fluidity of the model described in this paper. Simple single subject designs that emphasize control of many variables while allowing only one or a few variables to change will fail to capture this phenomenon. Clinical case study demonstrations will also be limited in the ability to empirically document these complex interactions of stimuli and responses. Methodologies that address setting events and analysis of complex stimulus and response relationships need to be refined further in order to adequately characterize these complex phenomena.

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Figure Captions

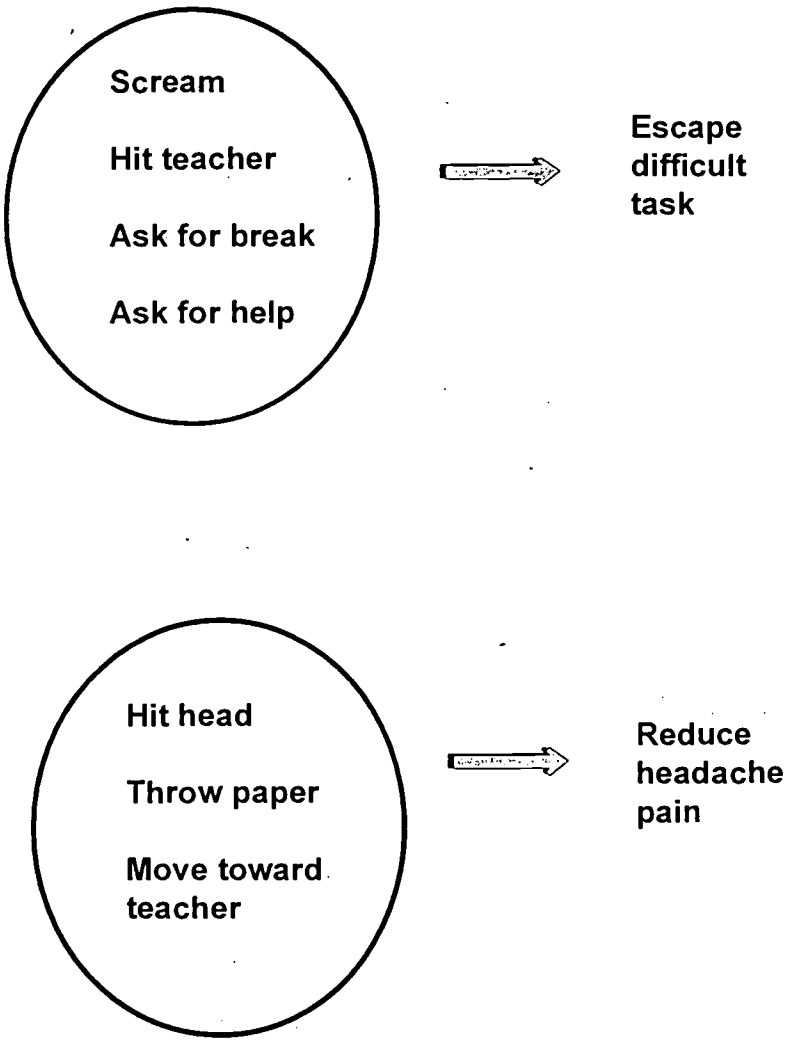
Figure 1. Two Response Classes

Figure 2. Expanded Model of Behavior Analysis

Figure 3. An Illustration of the Expanded Model of Behavior Analysis.

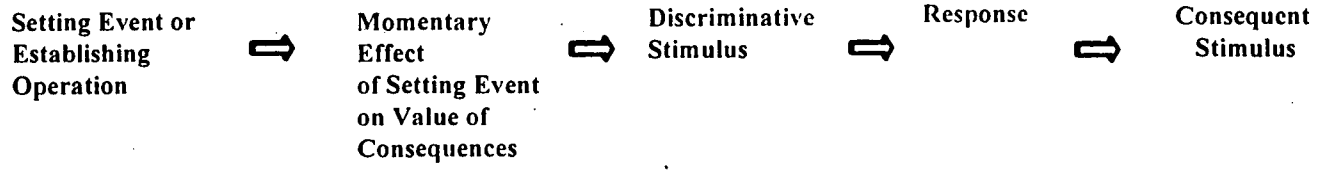
$S^e$ refers to setting events or establishing operations, $S^D$ refers to discriminative stimulus, and R refers to response.

Note. From "The Relationship Between Setting Events and Problem Behavior," by R. Horner, B. Vaughn, H. M. Day, & B. Ard, (in press). To be in L. Koegel, R. L. Koegel, & G. Dunlap (Ed.) Community, School and Social Inclusion Through Positive Behavioral Support. Adapted with permission.


Scream
Hit teacher
Ask for break
Ask for help
Escape difficult task
Hit head
Throw paper
Move toward teacher
Reduce headache pain

## Traditional Model of Behavior Analysis


## Expanded Model of Behavior Analysis



| Setting Events | Momentary Effect of Setting Event on Value of Consequences | ⇒ | Antecedent Stimuli | ⇒ | Available Responses | ⇒ | Consequences |
|---|---|---|---|---|---|---|---|
| $S^e_1$ Fight with peer | * Increase value of escaping hard tasks<br>* Decrease Value of teacher praise | | $S^D_1$ Teacher request to do task<br>$S^D_2$ Task materials | | $R_1$ Scream/Run<br>$R_2$ Throw materials<br>$R_3$ Ask for break<br>$R_4$ Ask for help | ⇒ | * Escape hard task |
| | | | | | $R_5$ Perform task | ⇒ | * Teacher praise<br>* More work |
| $S^e_2$ No breakfast | * Increase value of food | | $S^D_3$ Teacher places snack on back table | | $R_6$ Run to back table and grab snack | ⇒ | * Eat food |
| $S^e_3$ Headache | * Increase value of escaping hard tasks<br>* Decrease value of teacher praise<br>* Increase value of pain reduction<br>* Decrease valued of completing task | | | | $R_7$ Hit head<br>$R_8$ Rock<br>$R_9$ Sit in corner | ⇒ | * Reduced headache |

# Attachment B:
# Sample SDA Output

Sequential Data Analysis, Version 1.8.2
Date: 8-8-1994

File Name : tebblnb1.mrg
Coding Date : Date
Student Name : Student Name
Teacher Name : Teacher Name
Blank :
Observer : Observer
Blank :
Location : Location
Session Number: Session Number
Comments :Observations Conactenated

Initial Event Time: 301
Number of Events : 448

Data Sequence:

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 3 | S | 0 | S | 0 | S | 0 | S | S | X | S |
| 3 | 5 | 7 | 10 | 11 | 15 | 17 | 20 | 26 | 28 | 51 | 53 |
| 3 | 5 | 7 | 10 | 11 | 15 | 17 | 20 | 26 | 28 | 51 | 53 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| | | | | | | | | | | | |
| X | S | X | S | 0 | S | 0 | S | 3 | S | 0 | S |
| 59 | 61 | 62 | 66 | 78 | 79 | 81 | 83 | 90 | 91 | 94 | 95 |
| 59 | 61 | 62 | 66 | 78 | 79 | 81 | 83 | 90 | 91 | 94 | 95 |
| 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| | | | | | | | | | | | |
| 0 | S | 3 | 0 | X | S | X | S | X | S | X | S |
| 103 | 105 | 109 | 119 | 124 | 124 | 126 | 126 | 128 | 128 | 130 | 130 |
| 103 | 105 | 109 | 119 | 124 | 124 | 126 | 126 | 128 | 128 | 130 | 130 |
| 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 |
| | | | | | | | | | | | |
| X | S | X | S | X | S | X | 3 | X | S | 0 | S |
| 132 | 133 | 134 | 135 | 136 | 137 | 139 | 142 | 143 | 150 | 151 | 152 |
| 132 | 133 | 134 | 135 | 136 | 137 | 139 | 142 | 143 | 150 | 151 | 152 |
| 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 |
| | | | | | | | | | | | |
| 0 | S | 0 | 3 | P | 3 | S | X | S | 0 | S | X |
| 156 | 157 | 162 | 165 | 169 | 171 | 171 | 186 | 199 | 201 | 202 | 206 |
| 156 | 157 | 162 | 165 | 169 | 171 | 171 | 186 | 199 | 201 | 202 | 206 |
| 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| | | | | | | | | | | | |
| S | 0 | S | 0 | 3 | X | S | X | S | X | S | X |
| 207 | 208 | 209 | 212 | 217 | 219 | 232 | 234 | 234 | 237 | 237 | 240 |
| 207 | 208 | 209 | 212 | 217 | 219 | 232 | 234 | 234 | 237 | 237 | 240 |
| 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 |
| | | | | | | | | | | | |
| S | X | S | X | S | X | S | X | S | 0 | X | 3 |
| 241 | 242 | 243 | 245 | 245 | 247 | 248 | 250 | 250 | 252 | 253 | 256 |
| 241 | 242 | 243 | 245 | 245 | 247 | 248 | 250 | 250 | 252 | 253 | 256 |
| 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| X | S | S | X | S | X | S | X | S | X | S | X |
| 257 | 258 | 3 | 5 | 7 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 257 | 258 | 3 | 5 | 7 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 |
| S | 0 | S | 0 | S | 0 | S | 0 | P | S | P | S |
| 17 | 18 | 20 | 24 | 25 | 27 | 28 | 30 | 31 | 32 | 42 | 43 |
| 17 | 18 | 20 | 24 | 25 | 27 | 28 | 30 | 31 | 32 | 42 | 43 |
| 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 |
| P | X | S | X | 0 | S | 0 | P | S | 0 | P | S |
| 55 | 58 | 76 | 79 | 81 | 82 | 90 | 91 | 92 | 100 | 101 | 102 |
| 55 | 58 | 76 | 79 | 81 | 82 | 90 | 91 | 92 | 100 | 101 | 102 |
| 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| X | S | X | S | 0 | X | 0 | P | X | 0 | S | 0 |
| 106 | 107 | 109 | 109 | 111 | 112 | 137 | 139 | 145 | 148 | 150 | 166 |
| 106 | 107 | 109 | 109 | 111 | 112 | 137 | 139 | 145 | 148 | 150 | 166 |
| 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 |
| P | S | 0 | S | P | S | X | S | 0 | P | S | X |
| 166 | 168 | 170 | 171 | 172 | 173 | 174 | 175 | 178 | 178 | 179 | 240 |
| 166 | 168 | 170 | 171 | 172 | 173 | 174 | 175 | 178 | 178 | 179 | 240 |
| 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 |
| S | X | S | X | S | X | S | X | S | X | S | X |
| 242 | 242 | 246 | 247 | 247 | 249 | 249 | 250 | 251 | 252 | 253 | 255 |
| 242 | 242 | 246 | 247 | 247 | 249 | 249 | 250 | 251 | 252 | 253 | 255 |
| 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 |
| S | X | S | X | S | X | S | X | S | X | S | X |
| 256 | 257 | 258 | 259 | 260 | 262 | 263 | 264 | 265 | 265 | 267 | 271 |
| 256 | 257 | 258 | 259 | 260 | 262 | 263 | 264 | 265 | 265 | 267 | 271 |
| 157 | 158 | 159 | 160 | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 |
| S | X | S | X | S | X | S | X | S | X | X | S |
| 271 | 273 | 274 | 276 | 279 | 280 | 281 | 282 | 283 | 284 | 286 | 287 |
| 271 | 273 | 274 | 276 | 279 | 280 | 281 | 282 | 283 | 284 | 286 | 287 |
| 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| 3 | X | S | 0 | 3 | S | 0 | X | 0 | 3 | S | X |
| 3 | 6 | 9 | 11 | 14 | 14 | 19 | 21 | 22 | 25 | 26 | 30 |
| 3 | 6 | 9 | 11 | 14 | 14 | 19 | 21 | 22 | 25 | 26 | 30 |
| 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 |
| S | 0 | S | P | S | 0 | S | 0 | X | 3 | X | S |
| 30 | 34 | 35 | 36 | 38 | 41 | 42 | 46 | 49 | 50 | 51 | 61 |
| 30 | 34 | 35 | 36 | 38 | 41 | 42 | 46 | 49 | 50 | 51 | 61 |
| 193 | 194 | 195 | 196 | 197 | 198 | 199 | 200 | 201 | 202 | 203 | 204 |
| X | S | X | S | 0 | S | X | P | X | 0 | S | 0 |
| 65 | 67 | 69 | 69 | 74 | 74 | 75 | 76 | 77 | 83 | 85 | 88 |
| 65 | 67 | 69 | 69 | 74 | 74 | 75 | 76 | 77 | 83 | 85 | 88 |
| 205 | 206 | 207 | 208 | 209 | 210 | 211 | 212 | 213 | 214 | 215 | 216 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S | 3 | S | 0 | S | 0 | S | 3 | S | X | S | X |
| 88 | 91 | 93 | 94 | 95 | 98 | 99 | 107 | 108 | 111 | 111 | 113 |
| 88 | 91 | 93 | 94 | 95 | 98 | 99 | 107 | 108 | 111 | 111 | 113 |
| 217 | 218 | 219 | 220 | 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 |
| S | X | S | X | S | X | S | X | S | X | S | X |
| 114 | 117 | 117 | 120 | 120 | 122 | 123 | 125 | 125 | 129 | 129 | 131 |
| 114 | 117 | 117 | 120 | 120 | 122 | 123 | 125 | 125 | 129 | 129 | 131 |
| 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 | 240 |
| S | X | S | X | S | 0 | S | P | 0 | S | 3 | X |
| 131 | 133 | 134 | 135 | 135 | 136 | 139 | 140 | 141 | 142 | 145 | 148 |
| 131 | 133 | 134 | 135 | 135 | 136 | 139 | 140 | 141 | 142 | 145 | 148 |
| 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 |
| 0 | S | 3 | S | 0 | S | P | S | 0 | S | 0 | X |
| 155 | 157 | 158 | 159 | 172 | 173 | 175 | 177 | 178 | 179 | 184 | 186 |
| 155 | 157 | 158 | 159 | 172 | 173 | 175 | 177 | 178 | 179 | 184 | 186 |
| 253 | 254 | 255 | 256 | 257 | 258 | 259 | 260 | 261 | 262 | 263 | 264 |
| 0 | X | 3 | X | S | X | 0 | X | S | X | S | X |
| 190 | 191 | 193 | 0 | 199 | 206 | 208 | 209 | 211 | 213 | 213 | 215 |
| 190 | 191 | 193 | 0 | 199 | 206 | 208 | 209 | 211 | 213 | 213 | 215 |
| 265 | 266 | 267 | 268 | 269 | 270 | 271 | 272 | 273 | 274 | 275 | 276 |
| S | X | S | 0 | S | 0 | S | 0 | S | 0 | S | 3 |
| 215 | 217 | 219 | 219 | 221 | 227 | 227 | 232 | 233 | 235 | 236 | 238 |
| 215 | 217 | 219 | 219 | 221 | 227 | 227 | 232 | 233 | 235 | 236 | 238 |
| 277 | 278 | 279 | 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 |
| S | 0 | S | 0 | S | 3 | X | S | X | S | X | S |
| 240 | 241 | 242 | 245 | 246 | 250 | 251 | 251 | 253 | 253 | 255 | 255 |
| 240 | 241 | 242 | 245 | 246 | 250 | 251 | 251 | 253 | 253 | 255 | 255 |
| 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 |
| X | S | X | S | X | S | X | S | X | S | X | S |
| 257 | 257 | 259 | 260 | 262 | 262 | 264 | 264 | 266 | 266 | 267 | 267 |
| 257 | 257 | 259 | 260 | 262 | 262 | 264 | 264 | 266 | 266 | 267 | 267 |
| 301 | 302 | 303 | 304 | 305 | 306 | 307 | 308 | 309 | 310 | 311 | 312 |
| X | S | X | S | X | S | X | S | X | S | X | S |
| 269 | 269 | 271 | 271 | 273 | 273 | 275 | 276 | 278 | 278 | 279 | 279 |
| 269 | 269 | 271 | 271 | 273 | 273 | 275 | 276 | 278 | 278 | 279 | 279 |
| 313 | 314 | 315 | 316 | 317 | 318 | 319 | 320 | 321 | 322 | 323 | 324 |
| X | S | 0 | S | 3 | 0 | S | X | S | X | S | 0 |
| 282 | 288 | 289 | 290 | 291 | 293 | 294 | 4 | 4 | 6 | 6 | 10 |
| 282 | 288 | 289 | 290 | 291 | 293 | 294 | 4 | 4 | 6 | 6 | 10 |
| 325 | 326 | 327 | 328 | 329 | 330 | 331 | 332 | 333 | 334 | 335 | 336 |
| S | 0 | S | X | 0 | X | 3 | X | S | X | S | 0 |
| 11 | 12 | 14 | 16 | 26 | 29 | 30 | 33 | 34 | 36 | 36 | 38 |
| 11 | 12 | 14 | 16 | 26 | 29 | 30 | 33 | 34 | 36 | 36 | 38 |
| 337 | 338 | 339 | 340 | 341 | 342 | 343 | 344 | 345 | 346 | 347 | 348 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| X | S | X | S | 0 | X | S | 0 | S | P | S | 3 |
| 46 | 46 | 48 | 48 | 49 | 49 | 51 | 53 | 54 | 56 | 57 | 58 |
| 46 | 46 | 48 | 48 | 49 | 49 | 51 | 53 | 54 | 56 | 57 | 58 |
| 349 | 350 | 351 | 352 | 353 | 354 | 355 | 356 | 357 | 358 | 359 | 360 |
| S | 0 | S | 3 | S | X | S | 0 | S | 0 | S | 0 |
| 60 | 60 | 61 | 62 | 63 | 65 | 67 | 68 | 68 | 70 | 78 | 79 |
| 60 | 60 | 61 | 62 | 63 | 65 | 67 | 68 | 68 | 70 | 78 | 79 |
| 361 | 362 | 363 | 364 | 365 | 366 | 367 | 368 | 369 | 370 | 371 | 372 |
| S | 3 | S | P | S | 0 | S | 0 | S | 0 | P | 0 |
| 80 | 83 | 83 | 84 | 100 | 101 | 103 | 105 | 106 | 109 | 112 | 115 |
| 80 | 83 | 83 | 84 | 100 | 101 | 103 | 105 | 106 | 109 | 112 | 115 |
| 373 | 374 | 375 | 376 | 377 | 378 | 379 | 380 | 381 | 382 | 383 | 384 |
| P | S | 3 | S | 0 | S | 3 | S | P | S | 0 | S |
| 116 | 120 | 121 | 150 | 151 | 154 | 155 | 162 | 162 | 171 | 173 | 181 |
| 116 | 120 | 121 | 150 | 151 | 154 | 155 | 162 | 162 | 171 | 173 | 181 |
| 385 | 386 | 387 | 388 | 389 | 390 | 391 | 392 | 393 | 394 | 395 | 396 |
| 0 | S | 3 | S | X | S | 0 | S | P | 3 | S | X |
| 182 | 185 | 185 | 206 | 209 | 210 | 210 | 212 | 213 | 214 | 228 | 231 |
| 182 | 185 | 185 | 206 | 209 | 210 | 210 | 212 | 213 | 214 | 228 | 231 |
| 397 | 398 | 399 | 400 | 401 | 402 | 403 | 404 | 405 | 406 | 407 | 408 |
| S | X | S | X | 0 | S | 0 | 0 | S | P | S | X |
| 231 | 232 | 232 | 235 | 236 | 238 | 239 | 240 | 242 | 243 | 244 | 245 |
| 231 | 232 | 232 | 235 | 236 | 238 | 239 | 240 | 242 | 243 | 244 | 245 |
| 409 | 410 | 411 | 412 | 413 | 414 | 415 | 416 | 417 | 418 | 419 | 420 |
| S | X | S | X | S | 0 | S | 0 | S | X | S | 0 |
| 246 | 247 | 247 | 248 | 252 | 253 | 254 | 256 | 259 | 261 | 262 | 263 |
| 246 | 247 | 247 | 248 | 252 | 253 | 254 | 256 | 259 | 261 | 262 | 263 |
| 421 | 422 | 423 | 424 | 425 | 426 | 427 | 428 | 429 | 430 | 431 | 432 |
| P | 3 | 0 | S | 3 | S | 0 | S | 3 | S | X | S |
| 265 | 267 | 275 | 277 | 278 | 287 | 289 | 289 | 291 | 294 | 295 | 296 |
| 265 | 267 | 275 | 277 | 278 | 287 | 289 | 289 | 291 | 294 | 295 | 296 |
| 433 | 434 | 435 | 436 | 437 | 438 | 439 | 440 | 441 | 442 | 443 | 444 |
| X | S | X | S | | | | | | | | |
| 298 | 298 | 301 | 301 | | | | | | | | |
| 298 | 298 | 301 | 301 | | | | | | | | |
| 445 | 446 | 447 | 448 | | | | | | | | |

Number of Frequency Bins = 5

Frequency Distribution:

| 0 | 3 | P | S | X |
|---|---|---|---|---|
| 82 | 31 | 22 | 193 | 120 |
| 1 | 2 | 3 | 4 | 5 |

Transition Matrix (Lag = 1 ):

| | 0 | 3 | P | S | X |
|---|---|---|---|---|---|
| 0 | 1 | 5 | 9 | 56 | 11 |
| 3 | 3 | 0 | 1 | 18 | 9 |
| P | 2 | 3 | 0 | 14 | 3 |
| S | 65 | 18 | 11 | 2 | 96 |
| X | 10 | 5 | 1 | 103 | 1 |
| | 81 | 31 | 22 | 193 | 120 |

Conditional Probability Matrix (Lag = 1 ):

| | 0 | 3 | P | S | X |
|---|---|---|---|---|---|
| 0 | +0.01 | +0.06 | +0.11 | +0.68 | +0.13 |
| 3 | +0.10 | ***** | +0.03 | +0.58 | +0.29 |
| P | +0.09 | +0.14 | ***** | +0.64 | +0.14 |
| S | +0.34 | +0.09 | +0.06 | +0.01 | +0.50 |
| X | +0.08 | +0.04 | +0.01 | +0.86 | +0.01 |

Kappa Matrix (Lag = 1 ):

| | 0 | 3 | P | S | X |
|---|---|---|---|---|---|
| 0 | -0.21 | -0.03 | +0.28 | +0.44 | -0.18 |
| 3 | -0.11 | ***** | -0.03 | +0.26 | +0.03 |
| P | -0.11 | +0.07 | ***** | +0.36 | -0.18 |
| S | +0.64 | +0.26 | +0.12 | +0.26 | +0.65 |
| X | -0.20 | -0.15 | -0.30 | +0.75 | -0.36 |

Z Matrix (Lag = 1 ):

| | 0 | 3 | P | S | X |
|---|---|---|---|---|---|
| 0 | -4.43 | -0.33 | +2.80 | +5.12 | -3.03 |
| 3 | -1.29 | ***** | -0.45 | +1.76 | +0.28 |
| P | -1.15 | +1.27 | ***** | +2.01 | -1.43 |
| S | +7.34 | +1.76 | +0.68 | +5.45 | +9.57 |
| X | -3.31 | -1.39 | -2.42 | +11.08 | -7.51 |

Kappa Confidence Intervals (Lag = 1 ):

Confidence Level = +0.9500

| Event | Low | Kappa | High |
|---|---|---|---|
| 0 | -0.2472 | -0.2064 | -0.1656 |
| S | -0.8094 | -0.7415 | -0.6736 |
| X | -0.4034 | -0.3556 | -0.3077 |
| POP | -0.4497 | -0.3974 | -0.3450 |

Event S has Maximum Count = 193

# Attachment C:

# Experimental Analysis Research Report

Running head: SENSORY REINFORCEMENT

# The Effect of Noncontingent Sensory Reinforcement, Contingent Sensory Reinforcement, and Response Blocking on Stereotypical and Self-Injurious Behavior

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Abstract

Three experimental analyses were conducted to assess the effects of different consequent stimuli on the rate of self-injurious (SIB) and stereotypical behavior performed by two individuals with severe developmental disabilities and dual sensory impairments. An analogue functional analysis (Iwata et al., 1994) documented an undifferentiated pattern of problem behavior across play, alone, social, and demand contexts. Stimuli chosen based on the type of sensory stimulation produced by the SIB and stereotypy were presented noncontingently during play (low demand) conditions. Results indicated that noncontingent presentation of the specially selected stimuli resulted in reductions in SIB and stereotypy. Finally, contingent presentation of alternative sensory stimuli with and without response blocking was assessed in a demand context. Contingent presentation of the specially selected stimuli with problem response blocking was more effective than contingent sensory stimulus presentation alone. Results are discussed in terms of competing and concurrent schedules of reinforcement.

Descriptors: functional analysis, sensory reinforcement, competing reinforcement, self-injury, stereotypy

# The Effect of Noncontingent Sensory Reinforcement, Contingent Sensory Reinforcement, and Response Blocking on Stereotypical and Self-Injurious Behavior

Both self-injurious behavior (SIB) and stereotypy can manifest as rhythmic and/or repetitious patterns that vary in intensity, extent of injury, and disruption of the social environment. As such, some researchers have proposed that SIB and stereotypy share topographical, functional, and developmental similarities (Guess & Carr, 1991; Rojahn, 1994). While empirical documentation of the development and maintenance of SIB and stereotypy is incomplete, assessments and interventions based on reinforcement theory are the most thoroughly documented. Interventions based on developmental and physiological hypotheses have less empirical support (Linscheid & Valvano, 1987; Mason & Iwata, 1990).

The proposed causes of SIB and stereotypy fall into three major classes. The behavioral hypothesis states that SIB and stereotypy are maintained by positive and negative social or sensory (automatic) reinforcement (Iwata et al., 1994; Lovaas, Newsome, & Hickman, 1987). The social positive or negative reinforcement hypothesis states that these behavior topographies are maintained by socially mediated consequences. Thus, SIB and stereotypy can be maintained by access to attention or escape from aversive stimuli such as difficult instructional tasks (Horner & Day, 1991; Iwata et al., 1994, Horner, Day, Sprague, O'Brien, & Tuesday Heathfield, 1991). Behaviors that produce these stimulus classes may be treated by extinction in the form of ignoring (Wacker et al., 1990) or by preventing the behavior through response blocking (Sprague & Horner, 1992) while maintaining the presence of the aversive stimuli. An alternative behavior may also be taught that produces the same consequence as

the SIB or stereotypy (Durand & Carr, 1987). Other research has demonstrated that teaching a replacement behavior may not automatically result in a reduction of behavior unless it is of equal or superior efficiency (physical effort, schedule of reinforcement, latency to reinforcement) to the problem behavior (Horner et al., 1991).

The homeostasis or automatic reinforcement hypothesis (Iwata et al., 1994, Repp, Felce, & Barton, 1989) states that certain forms of SIB and stereotypy are performed to increase or reduce the overall level of external or internal sensory stimulation. These topographies are thought to produce sensory or "automatic" positive or negative reinforcing stimuli (Kootz & Cohen, 1981).

Some evidence points to a neurochemical etiology of SIB and stereotypy. Heightened levels of pain (e.g. headaches, sinus pressure), may be attenuated by head banging or other topographies. Repeated SIB or stereotypy may actually produce heightened levels of blood opioids, resulting in reduced pain sensation or a self-generated narcotic "high" (Thompson, Egli, Symons, & Delany, 1994).

The major contribution of modern functional analysis methods has been an increased ability to design interventions that are effective because they are designed to compete with or eliminate the specific maintaining consequences provided by the behavior (Neef & Iwata, 1994). Diagnosis and treatment involves (a) identification of the consequences of the self-injury, relative to the type and density of consequences for desirable behavior, (b) rearranging the relative reinforcement of the two such that undesirable behavior produces less reinforcement and appropriate behavior produces more, (c) including in the reinforcement for appropriate behavior the same type of reinforcement produced by the self-injury/stimulation,

and (d) altering the antecedent stimulus conditions which differentially control each behavior (Favell, McGimsey, & Schell, 1982; O'Neill, Horner, Albin, Storey, & Sprague, 1990).

The majority of intervention studies to date have focused on socially mediated SIB and stereotypy ( Carr, Taylor, Carlson, & Robinson, 1991; Cataldo, 1991). Etiology and treatment of behaviors maintained by sensory or automatic reinforcement (Kish, 1966, Iwata et al., 1994) remains less thoroughly investigated. The greatest challenge to the treatment of non-socially mediated behaviors is identifying a competing consequence to replace the stimulation produced by SIB and/or stereotypy (Rincover, Cook, Peoples, & Packard, 1979). In addition, as these types of SIB and stereotypy are self-delivered it can be difficult to apply sensory extinction procedures; especially when the behavior produces multiple types of sensory stimuli, (e.g. tactile and auditory combined) (Rincover & Devany, 1982). Finally, the properties of sensory reinforcement (e.g. schedule, quality, latency) are difficult to assess (Kish, 1966).

Research has focused on replacing stereotypy or SIB maintained by automatic reinforcement with a behavior that produces the same type of input (Favell et al., 1982); suppressing the behavior via sensory extinction (Rincover, 1978), or using reinforcement or punishment procedures to mask the reinforcing effect of the SIB or stereotypy (Mason & Iwata, 1990). The present study sought to extend the findings on treatments for non-socially mediated behavior by examining three different applications of competing sensory consequences. These included noncontingent sensory consequences, contingent sensory consequences, and contingent sensory consequences with response blocking. Specific research questions were:

1. Is there a functional relationship between the noncontingent presentation of sensory stimuli and the performance of self-injurious and stereotypical behavior?
2. Can sensory stimuli be applied contingently to reinforce (increase) a desirable behavior?
3. What is the relative effect of contingent sensory stimuli versus contingent sensory stimuli plus response blocking?

## Method

Participants and settings. Participants were two school age individuals with severe disabilities who engaged in high frequencies of self-stimulatory and self-abusive behaviors. Ben was a 9 year old boy with severe mental retardation, legal blindness, moderate hearing impairment, and chronic seizures. He also experienced chronic ear and sinus infections which were reported to be correlated with increases in self injury. He attended a self-contained classroom for students with severe disabilities within a regular public school building. Ben used some vocal speech in the form of echolalic expressions and "singing" when desired music was playing. All sessions for Ben were conducted in his classroom.

Theresa was a 20 year old woman with severe mental retardation, legal blindness, and moderate hearing impairment. She had chronic grand and petit mal seizures and used no vocal speech. She attended a self-contained classroom for students with severe disabilities at a regular public high school and lived in a six bed group home for adults with developmental disabilities. Sessions for Theresa were conducted in the living room of her home.

## Measurement

Data were collected using the PCS Collector software (Repp, Harman, Felce, Van Acker, & Karsh, 1989) and IBM compatible notebook computers. Individual teacher and

participant behaviors (both problem and adaptive topographies) were recorded from videotapes in a real-time format resulting in a frequency per minute measure. The PCS software segments sessions into continuous 1 second intervals. More than one behavior can be recorded within an interval. Percent time on task was also recorded for the final experimental analysis. Over 20 teacher and student behaviors were recorded and are summarized in Table 1. For Theresa, two behaviors (throw objects and run away) were considered escape behaviors and plotted separately for visual analysis.

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Insert Table 1 Here

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Inter-observer reliability. The PCS software (Repp et al., 1989) allows computation of inter-observer reliability by comparing the data stream from two different observers. Overall reliability as well as individual reliability assessments were collected on 21 (36%) of the sessions for Ben and 35 sessions (45%) for Theresa with at least one check in each phase of the three experiments (functional analysis, analysis of competing sensory reinforcement, analysis of contingent sensory reinforcement and response blocking). A window of +/- 3 seconds was utilized to determine if the same code was recorded by both observers. Overall reliability for Ben averaged 86% across all phases and behaviors (range 74-100%). Reliability for Theresa averaged 87.1% (range 73-100%). Data for individual participant and trainer behaviors are available from the senior author.

Design and Procedures

Three analyses were completed for each participant. These included an analogue functional analysis, a component analysis of competing sensory stimuli, and an analysis of

instruction with competing tactile or auditory reinforcement, with or without response blocking.

Analogue functional analysis. An initial indirect functional assessment interview (O'Neill, et al., 1990) was conducted with direct care staff for each participant to determine specific target behavior patterns. Based on the hypotheses developed through the interviews, an analogue functional analysis protocol was designed for each participant (Iwata et al., 1994) to determine the maintaining consequences for SIB and stereotypy. The functional analysis included four conditions including play, alone, social, and demand (Figures 1 & 2). Each of the four conditions was designed to determine if a particular class of reinforcement was more predictive of problem behavior (Iwata et al., 1994).

The play condition presented the participant with materials that were reported by direct care staff to be preferred (e.g. small play ball, koosh ball, children's toys). The trainer (either the second or third author) introduced the preferred items at the beginning of the session and reintroduced them if the participant stopped using an item for more than 15 seconds. Praise was also delivered at approximately a VI 30 s schedule for interacting with the items. In the alone condition, the participant was asked to sit in a chair or remain in the area (classroom for Ben, living room for Theresa) with no materials to interact with. No praise or trainer contact was delivered. In the social condition the same materials as the play condition were presented except that trainer attention was provided based on the performance of SIB or stereotypy. In the demand condition, participants were asked to participate in a task (completing a computer task for Ben, clearing dishes from the dining room for Theresa). Praise was delivered for task related behavior and a 10 second pause (demand cessation) was

provided contingent on the performance of SIB or stereotypy. Four functional analysis sessions were conducted with Ben and five with Theresa. Each condition was presented for 5 minutes in counterbalanced order across the sessions.

Component analysis of competing sensory stimuli. A component analysis of the effect of different sensory stimuli was designed based on the initial analogue functional analysis. As the behaviors for each participant appeared to be somewhat undifferentiated across the four conditions described above, an ABACADAE (Ben) ABACADAD'AE (Theresa) (Figures 3 & 4) analysis was completed to assess the differential effect of sensory stimuli that were concurrently and noncontingently (VI 5 s for tactile and auditory and VI30 or VI 15 for food) presented with no contingent social feedback for SIB and stereotypy. The baseline phase replicated the play condition from the analogue functional analysis.

The tactile condition included the materials from the play condition and in addition involved providing vibratory stimulation from a hand held cosmetic vibrator (Conair), or a vibrating pillow (JC Penney). The vibrator (Ben) or pillow (Theresa) was turned on and given to the participant every five seconds unless s/he continued to hold or maintain pressure from the device on some body part. Both Ben and Theresa tended to hold the devices to their face.

The auditory condition (C) included the materials from the play condition and in addition provided somewhat loud music from an electronic keyboard (Theresa) or preferred songs from a small tape player (Ben). Both participants were able to pick up the sound devices and often held them to their ears. The food condition included the play materials described above and presented preferred foods (chips, cookies, juice) at VI30 s only for Ben

and VI30 s and VI15 s for Theresa (D and D'). The tactile plus auditory (E) condition presented the participants with the play materials plus the devices available in the tactile and auditory condition. The trainer waited for the participant to approach an item and then provided assistance if needed to maintain contact with the device.

Analysis of instruction with contingent tactile or auditory reinforcement, and response blocking. The final analysis was designed to assess the effect of contingent presentation of the sensory stimuli with and without blocking SIB and stereotypy. In essence, could a specially assessed competing stimulus be used to positively reinforce an adaptive behavior? An ABCBC (Ben) and ABCBCBCBC (Theresa) analysis was conducted using the tasks utilized in the demand condition of the analogue functional analysis (Figures 5 & 6).

The baseline (A) phase used the same tasks presented in the demand condition of the analogue functional analysis. Participants were given instructions related to the chosen task and a cessation of demands for 10 seconds was delivered contingent on the performance of SIB or stereotypy. Praise was delivered for task attempts.

In contingent sensory stimulation with no block (B) participants were given 10 seconds of vibratory (Ben) or auditory (Theresa) stimulation contingent on the performance of task related behavior. Auditory stimulation was selected for Theresa as the vibrator interfered with performance of the demand task. SIB or stereotypy resulted in a 10 second cessation of demands and was not blocked. In contingent stimulation with block (C) vibratory or auditory stimulation was delivered on the same schedule as the "no block" phase and SIB or stereotypy was interrupted or followed by the trainer gently moving the participants' hand down and saying "please don't do that."

Results

The analogue functional analysis (Figures 1 & 2) indicated that each participant engaged in high rates of self-stimulatory and self-injurious behavior topographies across multiple conditions (Play, Alone, Social, & Demand). Ben displayed the highest rates of problem behavior in the alone condition (X=42.6 per min, range 37.6-48). Play, Social, and Demand conditions also resulted in high problem behavior rates (X=26.8, 27.8, & 24.5 per min, respectively).

The pattern for Theresa was somewhat differentiated for the demand condition. SIB and stereotypical behaviors were relatively lower during demand sessions (X=4.7 per min, range .6-7). A clearer pattern of undifferentiated SIB and stereotypy was observed across the play; alone, and social conditions (X=26.5, 25.9, & 18.1 per min, respectively).

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Insert Figures 1 & 2 About Here

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The analysis of competing sensory stimuli (Figures 3 & 4) indicated that noncontingent presentation of alternative sensory stimuli (tactile, auditory, or combinations) were more effective than traditional consequences such as praise or food in suppressing problem behavior. For Ben, the initial rates of SIB and stereotypy in the first Play baseline were observed at X=26.83 per min. Noncontingent tactile stimulus presentation resulted in an immediate drop to 5.2 per min (X=7.2). Return to baseline was associated with an increase to 23 then 34.6 per min (X=28.8). Minimal change occurred (X=23.9 per min) when noncontingent auditory stimuli (music) were presented. Ben mostly engaged in lower intensity behavior (less head hitting and screaming) during this phase. He appeared to

"enjoy" the music and as such engaged in more vestibular rocking and hand flapping. The third baseline phase (X=26.4 per min) was again followed by little change (X=25.8 per min) when noncontingent food was presented at FI 30 s. A final reversal from baseline (X=19.5 per min) to tactile plus auditory (X=7.48 per min) demonstrated an immediate decrease with one overlapping data point. Analysis of individual session data indicate that Ben primarily accessed the tactile stimulus in this final condition. This is consistent with the finding that competing tactile consequences were most effective in suppressing SIB and stereotypy.

Similar suppressive effects were observed in the competing stimulus analysis with Theresa. After an initial baseline with high and stable rates of SIB and stereotypy (X=26.7 per min), the rate of problem behavior fell dramatically (X=1.67) when noncontingent tactile stimuli were presented. The second baseline resulted in very high rates (X=37.9 per min) of problem behavior followed by an immediate but slightly less dramatic drop (X=4.15 per min) with noncontingent auditory stimuli. The third baseline (X=37.15) presented a return to high problem behavior rates followed by a clear but less dramatic reduction with the presentation of noncontingent food at VI 30 s (X=17.4 per min.). The fourth baseline replicated the return to higher rates of behavior (X=25.3 per min) and was followed by a larger drop with noncontingent food at VI 15sec (X=11.65 per min.) compared to food at VI 30 s. The final baseline (X=24.9 per min) preceded a drop to X=3.7 per min when tactile and auditory stimuli were concurrently available. For Theresa, both tactile and auditory stimuli appeared to compete effectively with the stimulation derived from performing SIB and stereotypical behaviors under play conditions. The final analysis was then conducted to determine if the suppressive effects documented in the Play condition would be replicated in a demand task.

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Insert Figures 3 & 4 About Here

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The analysis of instruction, blocking, and sensory reinforcement (Figures 5 & 6) revealed that self-injury and self-stimulation were not significantly suppressed when a specially selected consequence alone was provided on a DRO schedule. Problem behaviors were suppressed when a mild block and reprimand was applied in addition to the DRO schedule. Increases in adaptive behavior (measured as time on task) were somewhat correlated with decreases in problem behavior.

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Insert Figures 5 & 6 About Here

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For Ben, the initial baseline condition of demand, noncontingent SIB and stereotypy, and no blocking resulted in a stable and high (X=32.7 per min) rate of problem behavior similar to that observed in the analogue functional analysis. In contingent tactile with no block, an initial decrease was followed by a return to slightly lower than baseline rates (X=24.5 per min). On task behavior in this condition (X=34%) was nearly identical to the initial baseline (X=27.2%) with the exception of the last data point (53% time on task). In contingent tactile with block, rate of problem behavior performance dropped quickly to 8.6 per minute and remained low (X=8 per min). Concurrently, time on task increased and remained stable (X=56.6%) with overlap occurring between sessions 8 and 11. A return to contingent tactile with no block resulted in an immediate increase in problem behavior (X=17.5 per min) that remained lower than the initial no block condition. A slight overall decrease in time on task (X=52.3%) occurred but significant overlap existed between phases.

A final return to contingent tactile with block replicated the immediate reduction in problem behavior (X=5 per min). A concurrent increase in time on task followed by a drop in the last two sessions resulted in a slightly higher percentage for the phase (X=56.5%) but significant overlap with the previous phase provides a less dramatic effect.

For Theresa, the initial demand context with no blocking resulted in an average frequency of 10.85 per min. for problem behavior. Rates of SIB and stereotypy were slightly higher than escape behaviors. In contingent audio with no block, an immediate decrease in all problem behavior was followed by a rapid and dramatic increase in SIB and stereotypy (X=8.2 per min) and a later mild increase in escape behaviors (X=1.2 per min). Introduction of contingent audio with block resulted in an immediate decrease in SIB and stereotypy from 11.2 per min to 3.7 per min with an overall average of 5.3 per min. Escape behaviors were not observed until the final session of the phase (X=.06 per min). No increase in time on task was noted. In the second contingent audio with no block condition, overall rate of problem behaviors was not significantly changed (X=4.23 per min for both classes) and time on task actually increased slightly to X=.7%. The next three phase changes (sessions 16-25) were not associated with the expected reversal effect for problem behavior. SIB and stereotypy remained relatively stable with much overlap between phases. Escape behavior remained almost nonexistent. Concurrently, time on task continued to increase across the reversals (range .6%-20%). Anecdotal observation indicated that Theresa was "waiting" for the music to come on. In session 26-28 (contingent audio, no block) the rate of problem behavior again increased as predicted (X=10.7 per min) with another increase in time on task (X=17.6%). The final return to contingent audio with block resulted in a rapid decrease in

the rate of problem behavior from 8.8 to 1.6 per min by session 31 (X=4.21 per min). Time on task increased as high as 32% (X=20%). Escape behaviors remained relatively unchanged in sessions 10-36.

## Discussion

This study utilized an extended functional analysis protocol to assess the suppressive effects of competing sensory stimuli on the rate of performance of SIB and stereotypical behavior. A single case reversal design was utilized to assess the effect of competing contingent sensory reinforcement with and without response blocking on rates of problem behavior performance and time on task.

The analysis with Ben indicated that a stimulus that shared properties with the stimulation produced by his SIB and stereotypy (i.e. tactile) resulted in suppressed rates of these behaviors when applied noncontingently. This specially selected stimulus was associated with more suppression than food or praise. When used contingently within a demand context, Ben tended to distribute his behavior such that both sources of reinforcement (automatic and trainer delivered) were available. When one source of reinforcement was restricted via response blocking, the rate of SIB and stereotypy was decreased and concurrent increases in time on task were observed.

The outcomes for Ben may be discussed via concepts of the matching law (Davison & McCarthy, 1988; Herrnstein, 1970). In the analysis of competing sensory stimuli (experiment 2), the noncontingent application of tactile stimulation may have occurred at a richer schedule, intensity, or quality or reinforcement than the stimulation produced by SIB or stereotypy. It is possible then that auditory or food stimuli were simply not presented at a

competitive level on any of those dimensions. The present analysis did not directly investigate these variables.

In the blocking analysis, it appears that Ben was able to allocate his responding among at least three concurrent schedules of reinforcement within and across the conditions (Green & Streifel, 1988, Sprague & Horner, 1992). He could produce tactile and other types of sensory stimuli by engaging in SIB and stereotypy in baseline and no block conditions. He could gain access to trainer provided sensory consequences by engaging in task related behavior in the contingent tactile conditions. Finally, contingent response blocking from the trainer restricted access to SIB and stereotypy (extinction) and possibly introduced a punishment contingency during the block conditions. As predicted, when automatic and trainer delivered stimuli were available, both types of behavior were observed. When behavior that produced automatic reinforcement was restricted, behaviors resulting in trainer delivered reinforcement increased. The present design does not permit direct analysis of matching law variables and does not allow a component analysis of the potential punishment and extinction components of the trainer delivered response blocking.

Outcomes similar to Ben were observed with Theresa for tactile and auditory stimuli in the analysis of competing sensory stimulation. The effect of using the trainer delivered stimuli in the demand context is less clear. While the anticipated reversal effect was achieved across sessions 22-35, the series of reversals conducted in sessions 10-22 require alternative explanations. First, it may be that the schedule, intensity, and quality of the contingent reinforcement offered to Theresa were insufficient to compete with the automatic reinforcement available from her SIB and stereotypy. Second, in contrast to Ben, Theresa

displayed a better defined class of escape related behaviors (throwing and running). It is possible that the escape contingency present in the demand context further diluted the competing effects of the trainer delivered sensory reinforcement. Unfortunately, the present design does not permit further analysis.

Time on task and problem behavior did not covary strongly for either participant. This may be due to the relatively equal or lower value of the contingent application of the specially selected stimuli to on task behavior or to procedural idiosyncracies (i.e. timing and schedule of stimulus presentation). This phenomenon is perhaps most clear with Theresa where repeated reversals of the "block" and "no block" conditions were associated with concurrent but weak increases of time on task from sessions 13 through 28 and weak reversal effects on SIB and stereotypy. Anecdotal observation of the training sessions in this period reveal that while Theresa continued to engage in high rates of SIB and stereotypy, she would increasingly remain in the work area and look around for the tape player. Adjustments in the timing of reinforcer delivery (more immediate) at session 29 resulted in the expected reversal effect. It was observed that often the music would be turned on after Theresa had begun to engage in problem behavior. Thus, it is possible that Theresa had been conditioned to wait in proximity to the work area and music and did not learn the contingent relationship between on-task behavior and access to auditory stimulation until session 29 or 30.

The present results suggest a range of future research questions. First, many of the effects noted in the present analysis are likely due to uncontrolled variation in reinforcement schedule, quality, and match of the trainer delivered stimuli with stimuli generated by the SIB and stereotypy. Subsequent research in this area should utilize more precise measures of

stimulus intensity, quality, and schedule; especially when self-delivered (e.g. automatic reinforcement). Careful separation of these factors as independent variables would give further insight into the value of the Matching Law (Hernnstein, 1970) as a model to predict the distribution of human responses. A taxonomy of behaviors that produce automatic reinforcement should be produced and validated to promote consistent interpretation of reinforcement effects (Rojahn, 1994).

This study and others (Sprague & Horner, 1992) utilized response blocking as a method for restricting certain problem responses. Unfortunately, confounding extinction and punishment effects present in this technique are difficult to separate. Future research should utilize alternative methods for restricting problem responses to examine the relative value of competing schedules of reinforcement. In the present study, SIB and stereotypy was followed by a brief cessation of demands in the no block conditions. The block conditions restricted automatic reinforcement produced by SIB and stereotypy (extinction) but also introduced trainer attention for those behaviors (punishment to the extent that the behaviors decreased in probability). The operative mechanisms in the process are not clear in the present analysis. Similarly, the value of the trainer delivered sensory stimuli are confounded with the presence of trainer proximity. Mason & Iwata, (1990) attempted to control for this phenomenon by simply making the stimuli available in the environment. Their findings indicated limited or negative effects from providing "sensory stimulation." It is notable, however, that no effort was made to relate the type of sensory stimulation produced by the devices to that provided by the SIB.

The data for Theresa emphasize the need for further analysis of multiple response

classes within a given context. In this study, Theresa appeared to be engaging in demand escape behaviors and SIB and stereotypical behaviors (automatic reinforcement) in the demand condition of the analogue functional analysis and to a lesser extent in the blocking analysis. While no formal consequence (i.e. demand cessation) was provided for the escape behaviors, a brief pause in demands did result when she threw materials or attempted to leave the area. The specific contribution of this competing reinforcement schedule was not directly measured.

The present study provided an extension of our understanding of the role of automatic reinforcement and our ability to provide competing sensory consequences that function to suppress SIB and stereotypy. Specially assessed sensory stimuli were also used successfully to increase adaptive behavior for both participants. Support staff for Ben and Theresa reported that they were virtually "unteachable" due to their high rates of SIB and stereotypy. The present analysis demonstrated a method for shaping new, adaptive responses while reducing serious problem behavior.

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Table 1

Participant and Trainer Behaviors

| | |
|---|---|
| Ben | hand/object to face, slap ear, task attempt, hit object, hit head, hit face, touch head, cry, bite self, shake head, clap hands, rub hands, vocalization, body rock |
| Theresa | hand/object to face, hit others, task attempt, hit object, pinch self, bite trainer, pinch trainer, bite self, masturbate, crawl, throw object, rub hands, finger flick, chew clothes, scream, body rock, run away |
| Trainer | task request, other verbal/comment, physical prompt, reprimand/block, task request, praise |

Figure Captions

Figure 1. Analogue Functional Analysis Results for Ben Across Play, Alone, Social, and Demand Conditions. Figure displays frequency per minute of problem behavior.

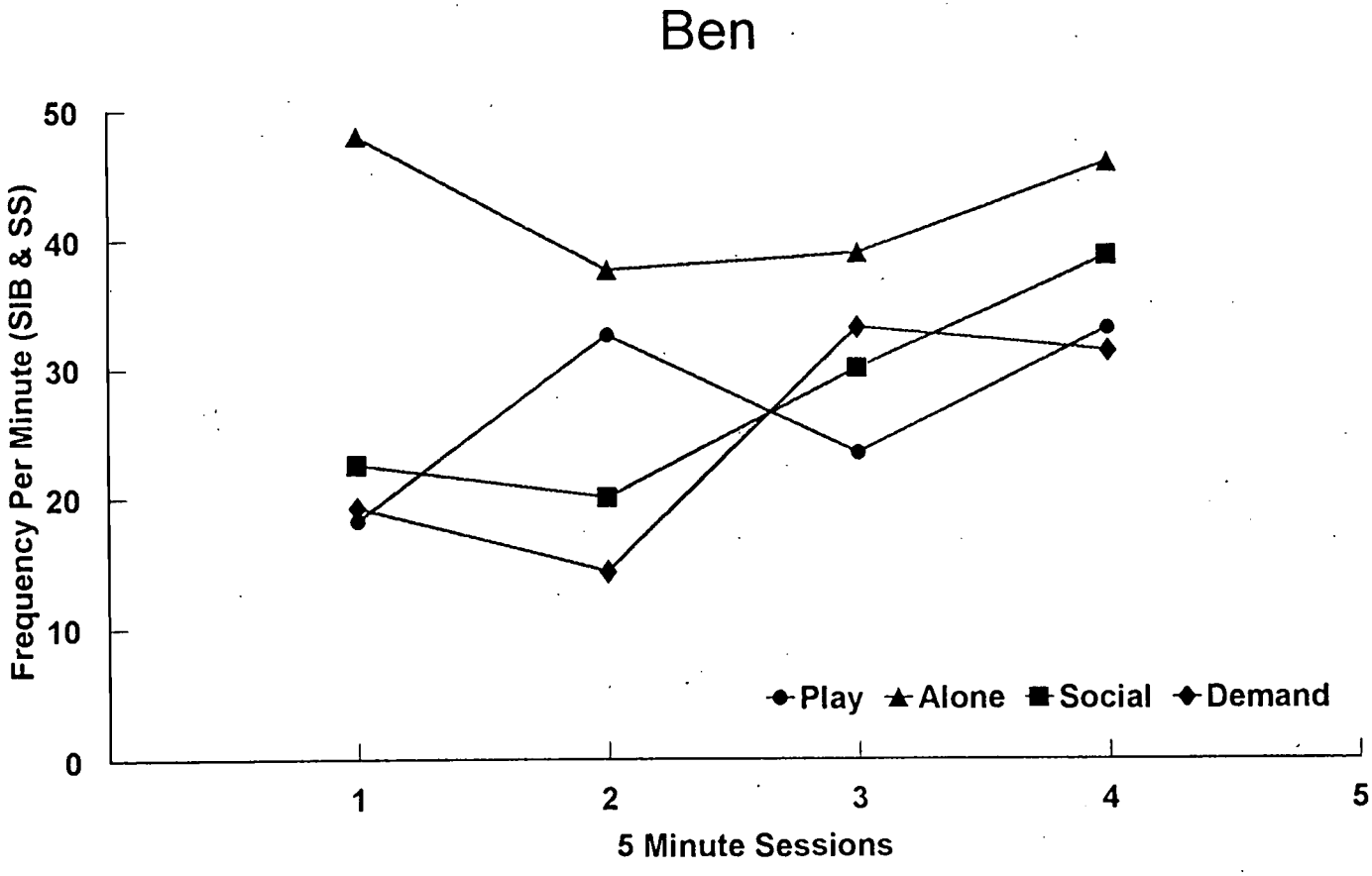
Figure 2. Analogue Functional Analysis Results for Theresa Across Play, Alone, Social, and Demand Conditions. Figure displays frequency per minute of problem behavior.

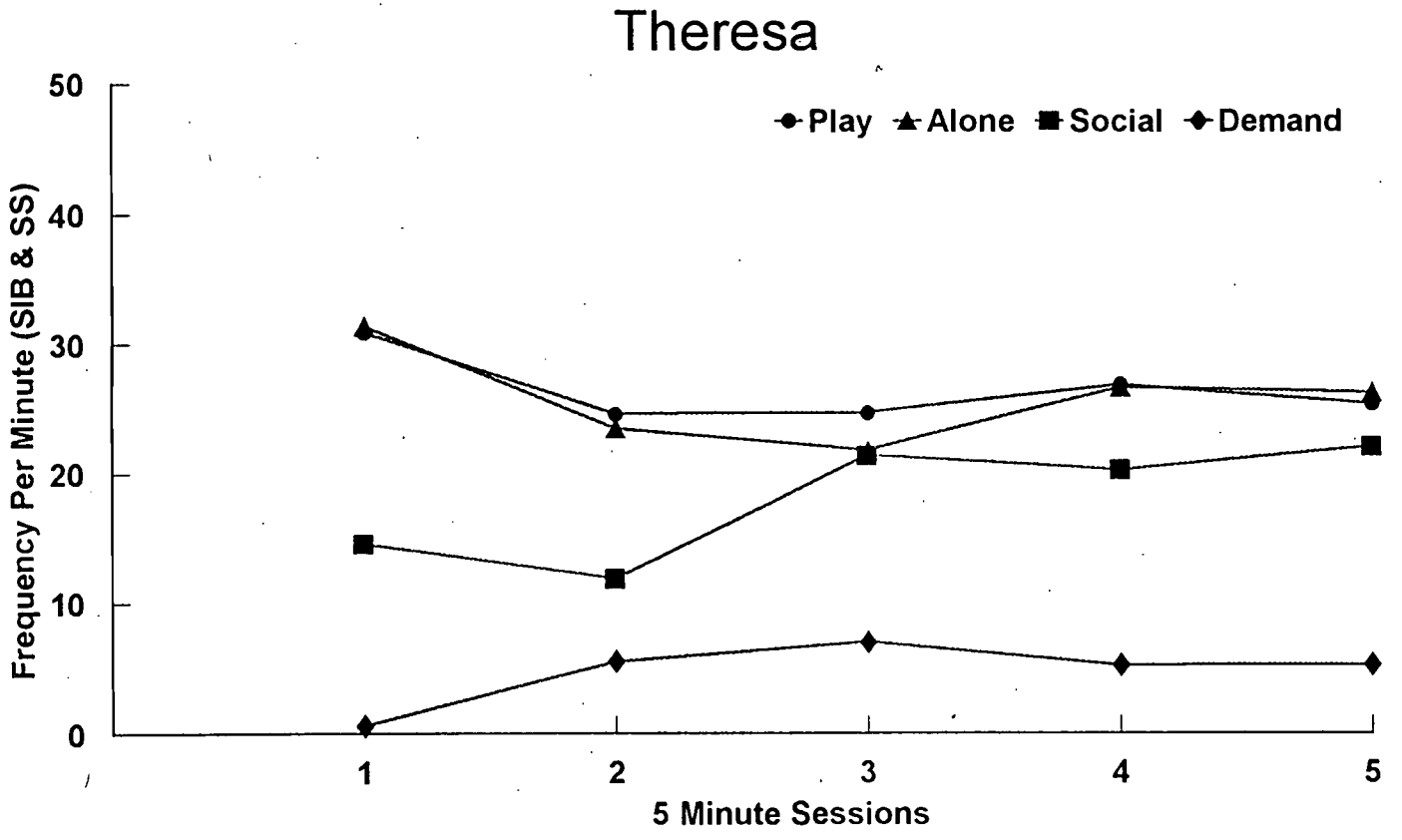
Figure 3. Results of the Component Analysis of Competing Sensory Stimuli for Ben. All conditions (baseline, tactile, auditory, food, and auditory plus tactile) included materials and procedures from the play condition in the analogue functional analysis.

Figure 4. Results of the Component Analysis of Competing Sensory Stimuli for Theresa. All conditions (baseline, tactile, auditory, food, and auditory plus tactile) included materials and procedures from the play condition in the analogue functional analysis.

Figure 5. Analysis of Contingent Reinforcement and Response Blocking for Ben. Figure displays frequency per minute of problem behavior.

Figure 6. Analysis of Contingent Reinforcement and Response Blocking for Theresa. Figure displays frequency per minute of problem behavior.


Ben
Frequency Per Minute (SIB & SS)
50
40
30
20
10
0
1
2
3
4
5
5 Minute Sessions
Play
Alone
Social
Demand


Theresa
Play
Alone
Social
Demand
Frequency Per Minute (SIB & SS)
50
40
30
20
10
0
1
2
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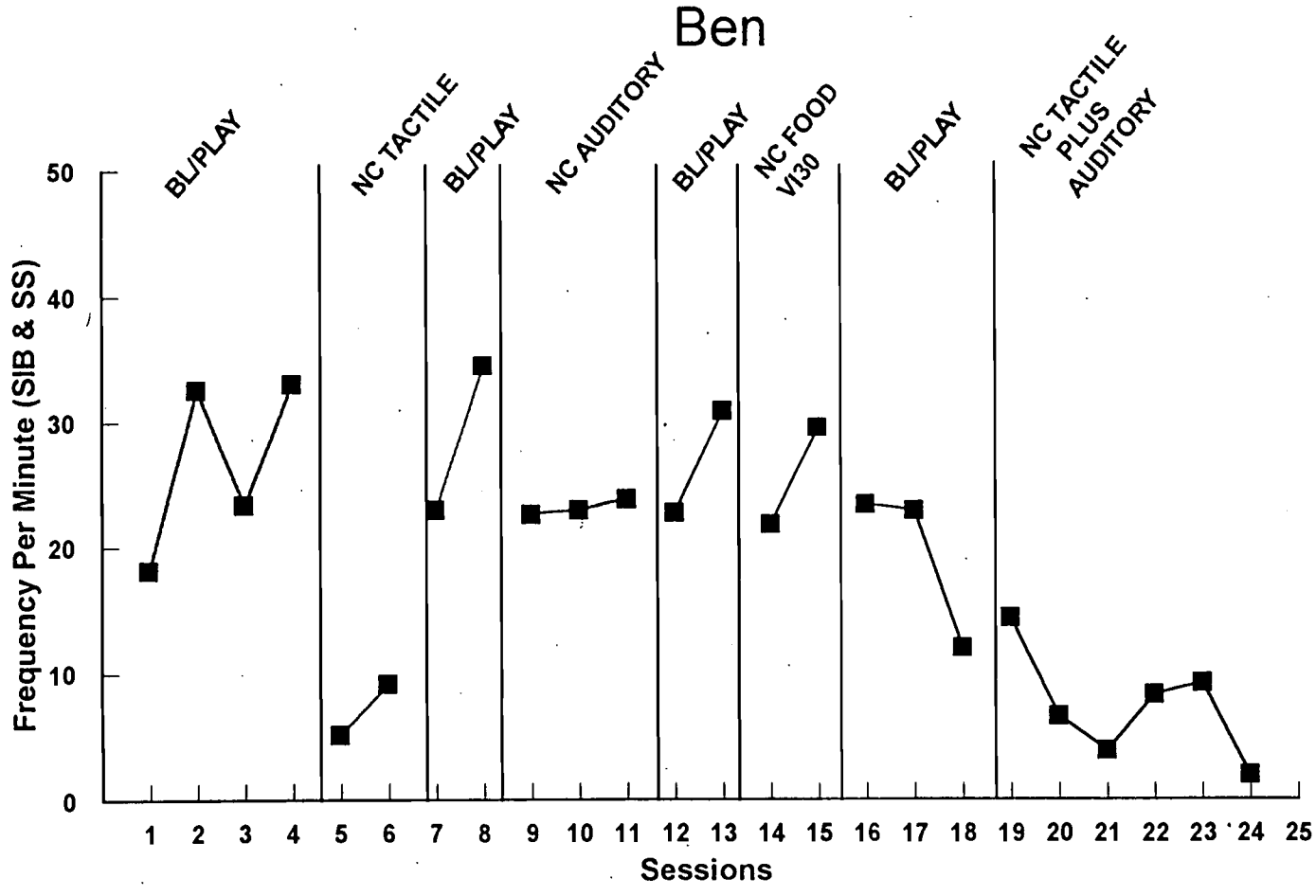
4
5
5 Minute Sessions


Ben
BL/PLAY
NC TACTILE
BL/PLAY
NC AUDITORY
BL/PLAY
NC FOOD VI30
BL/PLAY
NC TACTILE PLUS AUDITORY
Frequency Per Minute (SIB & SS)
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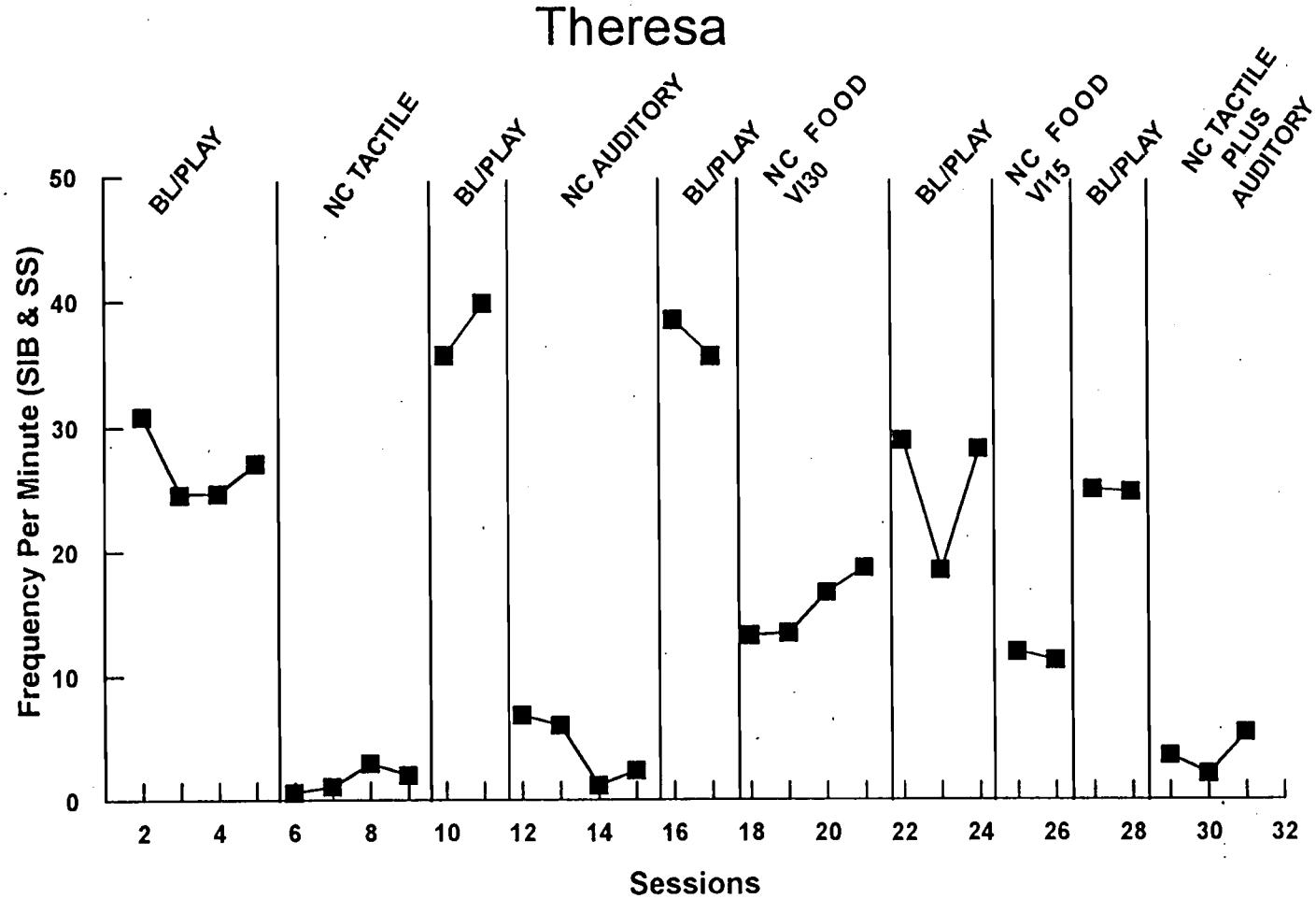
Sessions


Theresa
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NC FOOD VI30
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Frequency Per Minute (SIB & SS)
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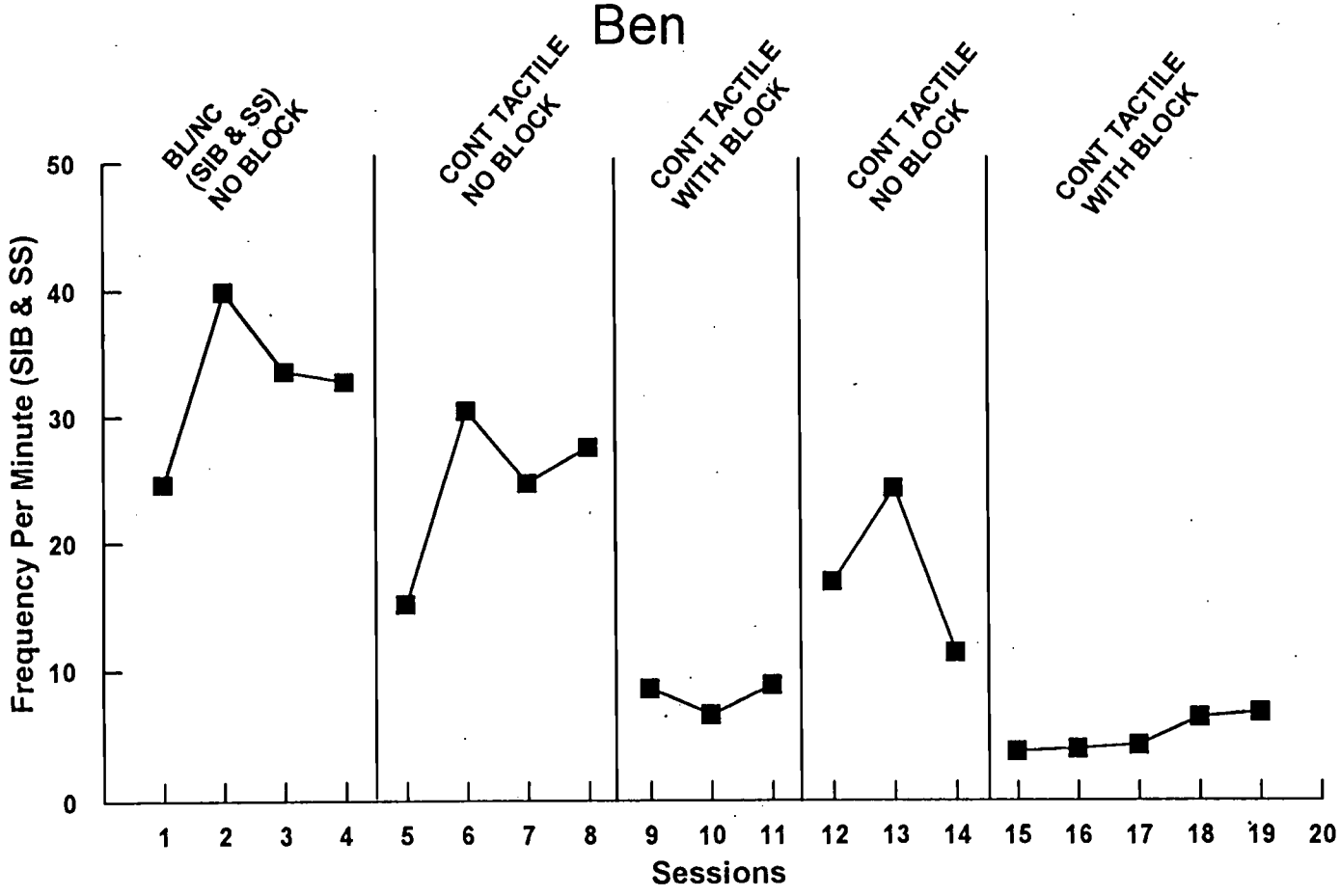
Sessions


Ben
BL/NC (SIB & SS) NO BLOCK
CONT TACTILE NO BLOCK
CONT TACTILE WITH BLOCK
CONT TACTILE NO BLOCK
CONT TACTILE WITH BLOCK
Frequency Per Minute (SIB & SS)
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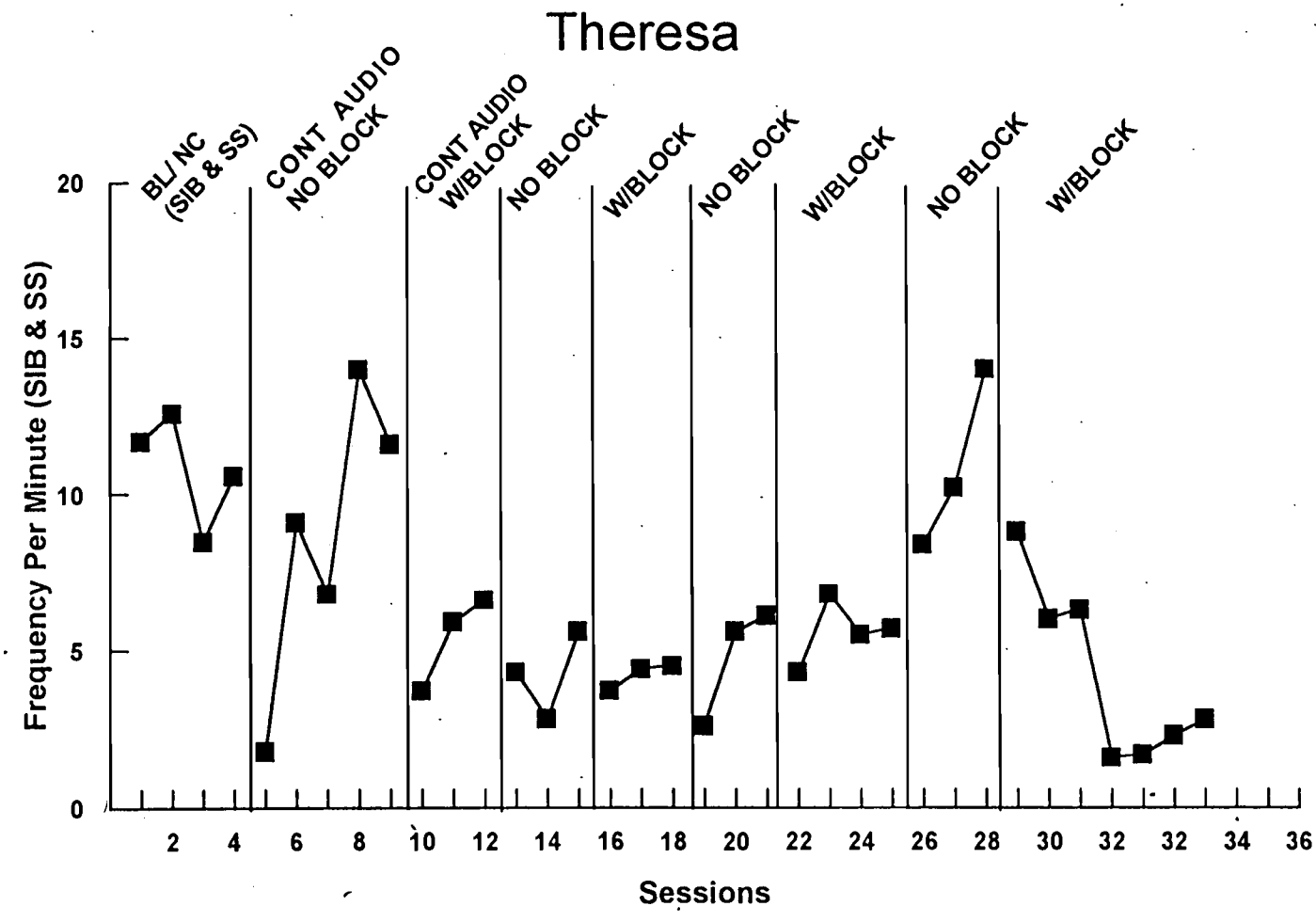
Sessions


Theresa
BL/ NC (SIB & SS)
CONT AUDIO NO BLOCK
CONT AUDIO W/BLOCK
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W/BLOCK
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NO BLOCK
W/BLOCK
Frequency Per Minute (SIB & SS)
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20
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Sessions

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